ANATOMY,

PHYSIOLOGY, AND HYGIENE:

A Manual

FOR THE USE OF

COLLEGES, SCHOOLS, AND GENERAL READERS.

BY

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PREFACE.

THE following pages are based upon the author's lectures in the public schools of Brooklyn for the last eight years. Both as a physician in active practice and as a teacher, he has been impressed with the importance of truthful anatomical pictures as educators; and of the folly, on the one hand, of omitting in our text-books important points; or, on the other, of overloading the mind with a mass of technical material, which is of little value to the ordinary student. For that matter, it is assumed throughout the work that the time has gone by when students are to be compelled to study the natural sciences by committing to memory page after page of text-books. In the preparation of the book the active co-operation of men distinguished in special lines of work has been obtained. The kind of type and the color of the paper were selected under the advice of the well-known physician and oculist, Dr. C. R. Agnew, of New York. Dr. L. C. Gray, Professor of Mental and Nervous Diseases in the New York Polyclinic Medical School, and Dr. J. C. Shaw, Superintendent of the King's County Insane Asylum, have carefully reviewed the manuscript and proof of the chapters on the Nervous System. In like manner, Dr. A. Mathewson, Ophthalmic Surgeon to St. John's Hospital, and the Brooklyn Eye and Ear Hospital, etc., has reviewed the chapters on Sight and Hearing. Dr. E. H. Bartley, Analytical Chemist to the Department of Health of the city of Brooklyn, and Lecturer on Chemistry at the Long Island College Hospital, has examined that portion of Chapter X. which relates to water; Dr. T. R. French, Consulting Laryngoscopic Surgeon to St. Mary's Hospital, etc., and Dr. S. Sherwell, Physician to the Throat Department of the Brooklyn Eye and Ear Hospital, have reviewed the manuscript and proof of the chapter on the Voice; and Dr. J. H. H. Burge, Surgeon

to the Long Island Hospital, has reviewed the manuscript and proof of the chapter on Emergencies. In addition to this public recognition of the services of the above-named gentlemen, thanks are also due to Dr. A. N. Bell, the well-known editor of *The Sanitarian*, for the use of his choice library of sanitary works, and for many valuable suggestions and criticisms; also to Dr. J. H. Hunt, for assistance in microscopic work, and to Dr. B. F. Westbrook, Chief of the Department of the Throat and Chest of St. Mary's Hospital, Brooklyn, for an original illustration and for valuable suggestions.

The book is believed to be a fair exponent of present physiological and hygienic knowledge. Throughout its pages the lessons of moderation are taught in connection with the use of each part of the body. The subjects of food, and of the relations of the skin to the various parts of the body and to health, are more thoroughly treated of than is ordinarily the case in such works. In regard to Stimulants and Narcotics, the main facts have been given. Care has been exerted to have *all* chapters reliable, not even omitting the one on Emergencies, which is often slighted in our text-books, thereby causing the directions given for the relief of the injured too frequently to be misleading. Figures 15, 21, 23, 24, 25, 32, 41, 44, 45, 47, 54, 64, and 66, were designed by the author, while the remainder of the illustrations are from Sappey's Descriptive Anatomy and other reliable sources, and are in the main new to text-books of this kind. It will be well for the teacher to see that the more important points stated in the Introduction, especially those relating to technical terms and certain processes, are comprehended by the pupil before entering upon the study of the text.

J. W.

BROOKLYN, *May* 7, 1884.

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INTRODUCTION.

1. The study now to be pursued is primarily that of *Health*. It includes a consideration of *Human Physiology*, or the science which teaches us how, in a physical point of view, "we live, and move, and have our being"; and under that head, of *Human Anatomy*, or the description of the location and structure of the various parts of the human body; and also of *Hygiene*, that is, the science and art of the preservation of health.[1] Wherever people have correct ideas as to the requirements of health, and make intelligent efforts to obey health laws, sickness is comparatively rare, and the very best work, both physical and mental, is accomplished. Not only does the individual help himself to progress and also those about him, but the community at large is benefitted, so that "public health is public wealth."

2. The human body, like that of the lower animals, begins in a microscopic cell, and passes through the various stages of birth, growth, development, decline, and death. The capa-

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[1] The word *Anatomy* is derived from the Greek (ανατομη), and signifies the act of cutting up, or dissection. Anatomical knowledge has been obtained by the dissection of bodies of the animal kingdom. The study of the general appearance and mutual relations of the bones, muscles, nerves, blood-vessels, and other parts, is sometimes called "general" or "gross anatomy," to distinguish it from the study, by means of the microscope, of "minute anatomy," *i.e.*, Histology.

The word *Physiology* is derived from the Greek (φυσιολογια), and signifies literally a talk about Nature. It is now confined to a description of "the phenomena the aggregate of which constitutes life." Physiological knowledge has been obtained by closely observing the actions of the various parts of living bodies in a state of health, and by means of operations upon living animals, that is, vivisection.

The word *Hygiene*, from a Greek word (ὑγιεια), *health*, refers particularly to the health of man, both individually and in relation to the community. The application of health laws to individuals is known as "individual hygiene," and to communities as "public hygiene," sanitation, or "preventive medicine."

city for development we possess, especially of the brain, is a marked distinction between man and other living organisms. In nothing do they all resemble each other so much as in their birth, decline, and death. There is in every portion of our bodies a final tendency to degeneration and death. In proportion to the care we take of our health is that degeneration slow and gradual.

3. The Chemist tells us that the body is composed of fourteen chemical elements, and that these and the substances which enter the body as food give rise to certain *chemical processes*, such as the conversion of starch into sugar, and the production of carbonic acid gas.

The Anatomist speaks of the body as composed of *organs*, *i.e.*, portions which have specific duties or *functions*. Thus the eyes are organs of sight, and the muscles organs of motion. He refers to the location, general structure, and mutual relations of these organs. He groups together those which have a similar texture into a *system*,—for example, the nervous system or the muscular system; and those which have a similar function under the head of an *apparatus*,—for example, the digestive apparatus. The processes with which his study is mainly concerned are largely *mechanical*, and are therefore sometimes called *mechanical processes*,—such as the comminution and grinding of the food in the mouth to fit it for swallowing; the motion of the muscles of the stomach in the digestion of food, and of other muscles in locomotion.

4. The Physiologist, on the contrary, looks upon all the processes which are carried on in the body as essentially *vital processes*, though the term is often limited to the circulation of the blood, breathing, and digestion. For all processes are alone made possible by means of a pervading influence called *life*, and through them life is maintained, and this "inherent power" enables the living body to assert its needs through its various parts. Thus, if it needs nourishment, it calls for it through the stomach by means of the "sensation of hunger";

when it needs air, the lungs make known a "desire for breathing." If the strength of the vital influence is diminished, impaired health results. If it ceases, what we call *death* follows. Thus there is death of a part, *i.e.*, local death, and death of the entire body, or general death. So intimately are the parts of the body, especially the internal organs, related to each other, that if one weakens or dies, others are liable to do likewise. This chain of vital connections constitutes the so-called "circle of life."

What is true of the entire body as to birth, growth, development, decline, and death, is also true, to a large extent, of each part, and of its structural elements.

5. Each individual part consists largely of bodies microscopic in size called *cells*, from the Latin *cella*, a closet or storeroom.[1] Their shape is more or less round, circular, fusiform, or stellate, depending on the structure in which they may be. Living cells are masses of contractile, jelly-like material called *protoplasm*,[2] which contains "at some period a smaller structure called *the nucleus*." This protoplasm possesses the vital property of altering its form. This power may be lost from too active stimulation or other causes. Besides the alteration in shape, some cells, like the *amoeba*,[3] have the power of locomotion by the protrusion and retraction of various portions of the protoplasmic mass. Movements of that sort are therefore known as the amoeboid movements.[4] Such movements are said to be especially characteristic of recently-formed or young cells, such as the white cells of the blood, lymph corpuscles, etc., and enable them at times to pass into tissues to which they do not belong, when they are called *emigrant* or *migratory* cells, and

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[1] "The cells range from the red blood cell ($\frac{1}{3000}$ inch) to the ganglion cell ($\frac{1}{300}$ inch)."

[2] From the Greek, *protos*, first, *plasma*, material. It is also called *bioplasm*, *i.e.*, life material.

[3] Simply constructed, minute animals.

[4] "The amoeboid movement enables many of the lower animals to capture their prey, which they accomplish by simply flowing round and enclosing it."—KIRKE.

may be the cause of disorder and disease. Certain cells, such as those in some portions of the respiratory passages, have a peculiar motion known as ciliary motion or action, due to the vibration of *ciliae*,[1] or microscopic *hair-like* filaments projecting from the cells. All cells are capable of producing cells like themselves. This process is known as cell reproduction or proliferation. The whole process involved in the formation and birth of a cell occupies, it is believed, but a few minutes of time, while the entire life of cells is probably measured by days.

6. Hence there is constant molecular death in the body, and the components of the body, instead of completely changing but once in seven years, as was once taught, are undergoing such constant change that most of them are renewed many times in that period. The brief existence of cells is brought to an end principally by mechanical abrasion and chemical transformation. The first mode occurs in the mouth and digestive tract; for example, when the cells covering the lining of these parts are rubbed off by the movements of the parts and by whatever is in contact with them. The second mode is seen in the fatty, pigmentary, and calcareous deposits which occur in certain parts under certain circumstances.

7. Though cells have but a brief existence, they are busy workers while they live. They have the power of absorbing material from surrounding cells or from the blood as it reaches them; of transforming the material so absorbed for their own use; of *excretion*, or the throwing out of waste material; and in some instances of separation from the blood of certain materials which in a changed form are afterwards given out as a *secretion*. The power of *selection and assimilation* is one of the wonders of cell life. Each cell in health takes from the blood the material needed for its life.[2] Certain cells elongate and form fibres.

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[1] From the Latin, meaning *an eyelash*.

[2] In disease, certain cells, such as those of the lymph, one of the circulating fluids of the body, may convey to other cells, or the latter may themselves take up foreign particles. Hair, for example, has been thus produced in the interior of the body.

8. Cells are connected either by a delicate viscid material known as intercellular substance, or by their processes or extremities. Through the development, union, and connection of cells the various *tissues* of the body are formed, such as membranes, the walls of delicate blood-vessels, muscle fibres, and nerve matter. These tissues are united in various ways to form the *organs*.

9. Some membranes, when placed as partitions between two fluids or gases, permit them to mingle. This process is known as *osmosis*. The passage of the fluid or gas inwards is *endosmosis;* outwards, *exosmosis*. The absorption of a fluid by a cell or membrane is *imbibition*. These vital processes are illustrated either in the changes which occur in the breathed air during respiration, or in the transformation of food into blood.

10. The various tissues of the body may be *classified* as *connective tissues* and *active tissues*, the latter, muscles, nerves, etc., being those by which the activities of the body are performed.

The connective tissues, as the name implies, connect and hold in place the various organs of the body. These tissues are either of bone, cartilage, or fat, or of gelatinous, elastic, or fibrous material. Their chief function is that of support. Delicate connective tissues so closely cover, or is so interwoven with all the textures of the body, that if all the other tissue could be removed and the connective only be left in normal position, we should have an almost exact model of nearly every organ in the body, even to its minutest structure. What connective tissue is will be best understood if we compare it with that of an orange after the juice has been sucked out. The framework alone is left, and this framework is the connective tissue. As motion is necessary to life, it will be appreciated how thickening of the connective tissue, which sometimes results from disease, will impair the motion and consequent health of parts.

11. Before entering upon the study of individual tissues and organs, their structure, function, and the best methods of preserving their health, attention should be called to our method

of study. It is deemed advisable to begin with the bony skeleton, then to study the tissues which overlie it, then those that are within it, and finally to show how all the parts may act in harmony by means of the brain, nerves, and the special senses.

The following groups of tissues and fluids of the body are in the main as arranged by the distinguished teacher of Anatomy and Physiology, Prof. C. L. Ford.

TISSUES OF THE BODY.

1. ***Osseous*** — Bones and teeth.
2. ***Cartilaginous*** — Pure cartilage and fibro-cartilage.
3. ***Fibrous*** — White and yellow, *i.e.*, the firm and strong, to bind parts together, and the elastic to afford elasticity and freedom of movement.
4. ***Muscular*** — Striated or voluntary muscles, and non-striated or involuntary.
5. ***Adipose*** — Fat cells and enclosed fat.
6. ***Epithelial*** — Epithelium, epidermis, hair, and nails.
7. ***Nervous*** — Cerebro-spinal and sympathetic.

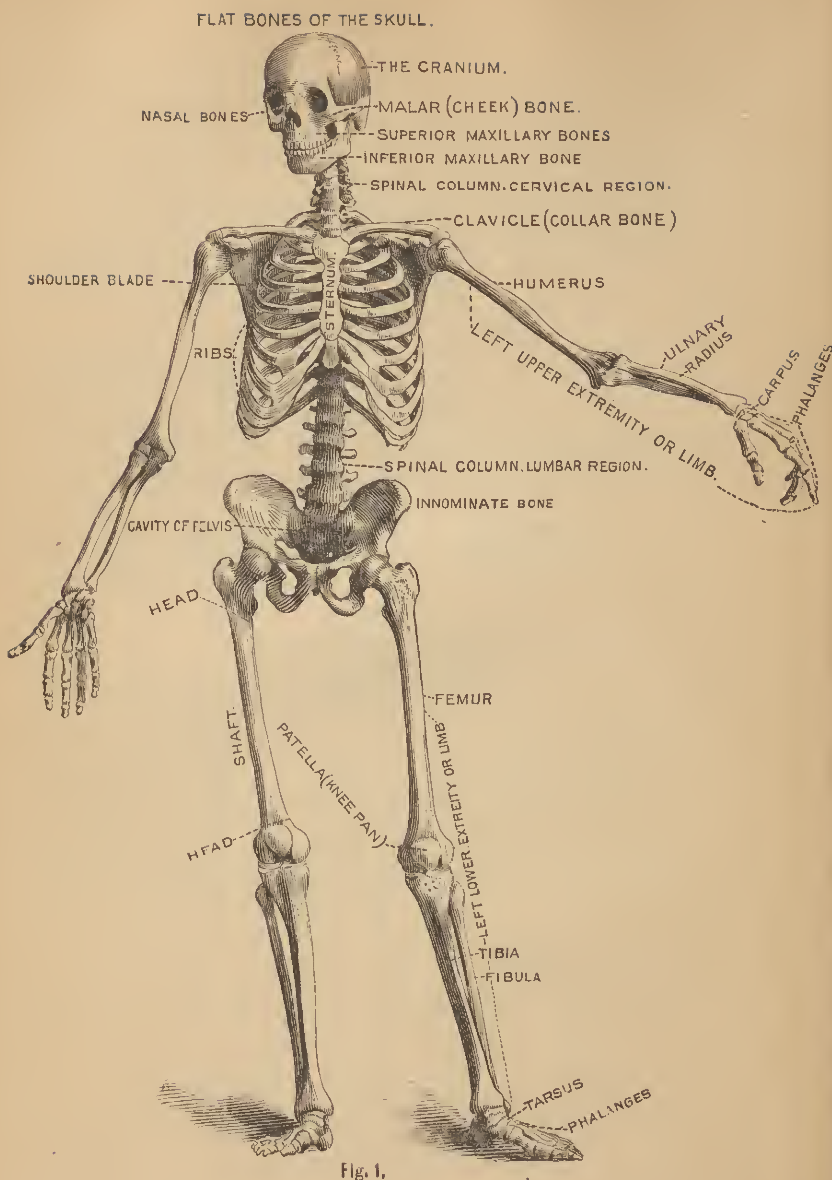
FLUIDS OF THE BODY.

1. ***Circulating Fluids*** — Chyle, lymph, blood.
2. ***Fluids for Digestion*** — Saliva, gastric secretion, pancreatic fluid, bile, intestinal juice.
3. ***Fluids of Closed Cavities*** — Of the arachnoid, pleural, pericardial, and peritoneal sacs, of joints, of the eye, and ear, and of cells.
4. ***Secretions for Protection*** — Cerumen or wax, tears, fluid of mucous membranes, oily fluids on the surface of body.
5. ***Fluids for Discharge*** — Intestinal secretion, *renal* or kidney secretion, perspiration, vapor from the lungs, etc.

ANATOMY, PHYSIOLOGY,

AND

HYGIENE.



FLAT BONES OF THE SKULL.
THE CRANIUM.
NASAL BONES
MALAR (CHEEK) BONE.
SUPERIOR MAXILLARY BONES
INFERIOR MAXILLARY BONE
SPINAL COLUMN. CERVICAL REGION.
CLAVICLE (COLLAR BONE)
SHOULDER BLADE
STERNUM.
HUMERUS
RIBS
LEFT UPPER EXTREMITY OR LIMB.
ULNARY
RADIUS
CARPUS
PHALANGES
SPINAL COLUMN. LUMBAR REGION.
INNOMINATE BONE
CAVITY OF PELVIS
HEAD
FEMUR
SHAFT
PATELLA (KNEE PAN)
LEFT LOWER EXTREITY OR LIMB
HEAD
TIBIA
FIBULA
TARSUS
PHALANGES

Fig. 1.

CHAPTER I.

BONES AND JOINTS.

1. The general figure and stability of the human body are maintained by the bones. Of these the framework or skeleton is constructed. This framework encloses cavities for the lodgement and protection of the vital organs. It has joints to facilitate motion, and surfaces for the attachment and support of the softer parts of the body.

In the entire skeleton of an adult there are 204 distinct bones.[1] The relations of these to each other are shown in Fig. 1.

2. All bones vary in *form*, and though they are more or less irregular, they may be considered as Long, Short, and Flat.[2]

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[1]

Bones of the spinal column	26
The cranium (skull)	8
The ears	6
The face	14
Ribs, hyoid bone, and breast bone	26
The upper extremities	64
The lower extremities	60
Total	204

This enumeration does not include the patellae (knee pans) or other sesamoid bones, — *i.e.*, bones having the form of seed. These are situated in the tendons or strings of certain muscles, where unusual pressure is exerted by the gliding movements of the tendons. Neither does it include the 32 teeth nor certain supernumerary bones, called *Wormian bones*, which are sometimes found in incomplete joints of the skull. Teeth are sometimes spoken of as composed of bony or osseous tissue, but they "differ from bone in structure, development, and mode of growth."

[2] Examples of the more irregular bones are the vertebrae, and some of the bones of the skull. These last are the temporal, sphenoid, ethmoid, superior maxillary (upper jaw), inferior maxillary (lower jaw), the palate bones in the roof of the mouth, the inferior turbinated bones in the nose.

The *long bones* are hollow shafts with two extremities, called *heads*, which are generally expanded, the better to form joints and to afford increased surface for the attachment of muscles and ligaments. (Fig. 1, right leg.) "They represent columns for supporting the weight of the body, or levers of different kinds for the muscles to act upon." The long bones are the clavicle (collar bone), the humerus (arm bone), the radius and ulna (forearm bones), the femur (thigh bone), the tibia and fibula (leg bones), and some of the bones of the hands and feet.

3. The *short bones* are located in those parts of the body where strength, compactness, and elasticity are required. They are strongly bound together by ligaments. Examples of short bones are found in the wrist and ankle.

4. The *flat bones* afford broad surfaces for muscular attachment, and serve to protect important organs. They are the shoulder blades, breast bone, ribs, hip bones, and some of the bones of the skull.

5. The *structure* of bones is as follows: —

On the surfaces of bones are various eminences[1] and depressions.[2] The first afford attachment for muscles, tendons, and connective tissue; the latter, safe and convenient passages for blood-vessels, nerves, tendons, and muscles. Through the surfaces of the bones are openings for the passage of blood-vessels, nerves, etc. These openings are especially numerous at the extremities of long bones.

6. All bones are enveloped in a firm vascular[3] membrane (the *periosteum*), except on the surfaces of joints, where they are overlaid with a smooth, elastic tissue known

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[1] Tuberosities, tubercles, spines, and ridges.

[2] Grooves, furrows, fissures, and notches.

[3] *i.e.*, full of blood-vessels.

as *cartilage.* The periosteum clings closely to the bone and nourishes it, and is capable, with the aid of the surrounding soft tissues, of producing new bone to replace that removed by disease or surgical operations.[1]

Fig. 2.
Posterior view of femur, showing the ridges, depressions, and openings.

Fig. 3.
Longitudinal section of femur, showing the compact and cancellous tissue of bone.

7. If a bone be sawn across, its walls will be found to be very hard and strong, like ivory. This firm tissue is called the *compact tissue.* In a long bone it is thicker in the middle of the shaft than at the extremities, where it disappears in a fine net-work tissue, called the *spongy* or *cancellous tissue.* The size of the bone along the shaft, where strength is mainly required, is thus diminished; while at the ends the extent of surface which is needed is obtained without increase of weight. The more expanded and elastic spongy tissue serves, too, both at the extremities of the long bones and in the interior of the other bones, to deaden the force of concussions. It is ordinarily filled with the oily material known as *marrow*, which also fills the hollow shaft or tube of the long bones. This tube

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[1] Hence the surgeon, in removing dead bone, removes as little of the periosteum as possible, and thus has succeeded, with the aid of nature, in producing new lower jaws, and even arm bones.

or central canal is therefore called the *medullary canal* (*i.e.*, marrow canal). It is lined by a vascular web of connective tissue known as the *endostium* or *medullary membrane*, which nourishes the inner parts of the bone.

8. Bones are *composed* of *animal matter*, mostly gelatine, and *mineral matter* ("bone earth"), chiefly calcium phosphate.[1] The animal matter, in combination, renders bones tough and elastic, enabling them to bear without injury ordinary shocks, while the mineral matter makes them hard and rigid, and capable of sustaining weights and strains without change of shape. Prof. Robinson found that a piece of bone one inch square bore a weight of five thousand pounds without breaking.[2]

9. In youth, the animal matter constitutes more than one-third of the bone substance; and hence the bones of children are more elastic than those of adults, and are less liable to be broken. As the child grows, the bones become stronger — being adapted to the increasing muscular strength. In adult life, mineral matter constitutes two-thirds of the bone substance. The bones are then very strong, though retaining considerable elasticity. In old age, the bones become very brittle from an excess of mineral

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[1] If a bone be immersed in a dilute acid (as muriatic, for instance), for a sufficient time, the mineral matter will be dissolved, while the animal matter will remain in the perfect shape of the bone, which may now be bent, or even tied in a knot. If a bone be exposed to the action of fire, the animal matter will be burned out, and the substance remaining in the shape of the bone will crumble when touched.

[2] "Bone has been found by experiment to possess twice the resisting property of solid oak. It is also elastic, as is shown by the resiliency of the fibula when its shaft is pressed against its tibia; and by Mr. Ward's experiment of placing the clavicle at right angles against a hard body, and striking the free end a smart blow with a hammer, when the bone will rebound a distance of two feet." — *Treatise on the Skeleton:* G. M. Humphrey, Esq., *M. B. Cantab. F.R.C.S.*

matter, and are liable to break from slight causes. An aged person, incautiously stepping from even a foot-stool or curb-stone, may break his thigh bone.

10. Sometimes bones become brittle as the result of disease. On the other hand, the bones of young children, whose food is deficient in mineral elements, may contain but one-fifth of mineral matter, and be rendered so soft and flexible as to be readily distorted by muscular contraction and by weights which they should normally sustain. This diseased condition is known as *rickets*.[1]

11. The *nutrition* of bones during life renders them very different from those of the dried skeleton. Living bones are well supplied with blood through the blood-vessels of the periosteum and endostium.[2] Even the compact tissue, solid as it appears to the eye, under the microscope is found to contain numerous vascular canals. The larger of these run lengthwise with the bones, and are connected with each other and with the periosteum and endostium by transverse and slightly oblique canals, in the course of which are enlargements or small reservoirs.[3] In addition to blood-vessels, there are found in bones nerves, and, ac-

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[1] In very early life bones are soft and cartilaginous. Gradually they become harder, as food supplies the necessary phosphatic salts. Finally, cartilage is replaced by bone. If, during the growth and development of children, proper food is not supplied, various deformities may result.

[2] Students are apt to judge of bones in the body by the dried specimens in lecture-rooms and museums, but they are as much unlike as the green and dead twigs of a tree.

A bone of an animal recently killed will be found to have a pinkish hue, due to the blood it contains.

If madder be mixed with the food of an animal, its coloring matter passes into the blood, and after a short time the bones become red. If the madder be given on alternate days, the bones will be marked alternately red and white.

[3] The longitudinal canals are called *Haversian* canals, from Clopton Havers, their discoverer; the transverse canals, *canaliculi;* the reservoirs, *lacunae.* The Haversian canals, the canaliculi, and the lacunae together, constitute the Haversian system of canals.

cording to some authorities, lymphatics.[1] They are therefore nourished by the same means that other and softer tissues are, and like them have the power of selecting from the blood, and appropriating to their own structure, the substances needed for their growth and development. This process is known as *assimilation.*

Fig. 4.

Longitudinal canals in compact tissue of bones, with their connecting canaliculi and the lacunae. Magnified 200 diameters.

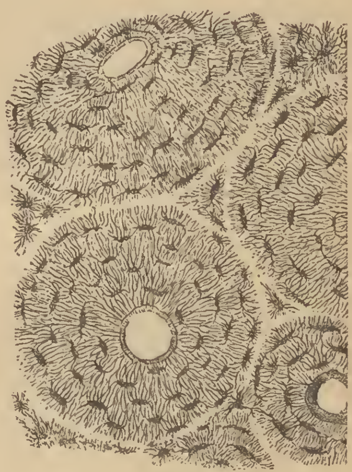

Fig. 5.

Transverse section of compact tissue of bones, showing openings of longitudinal canals, the canaliculi and lacunae. Magnified 200 diameters. The fine lines are canaliculi; the dark spots lacunae.

12. Joints. — The junction of two or more bones constitutes a joint, or, more technically, an articulation. Joints are classified as *immovable*, *mixed*, and *movable*. The joints of the cranial bones,[2] called *sutures* or *dove-tail joints*, are

[1] Lymphatics are vessels that carry lymph (§ 249). The nerves of bone are few in number, so that bones are generally but slightly sensitive. But, when inflamed, they become acutely sensitive, the nerves being pressed upon in their bony canals by the products of inflammation.

[2] Skull. See Fig. 6.

immovable; those of the vertebrae[1] are *mixed.* Most of the other joints of the body are movable. The varieties of these are the ball and socket joints, of which the shoulder and hip are examples; and hinge joints, to which class the knee and elbow belong.

13. The skull rests and *nods* upon the first vertebra or the *atlas*, and also upon a tooth-like process of the *axis*,

Fig. 6.
Suture joints of the skull.

Fig. 7.
Hip joint (ball and socket).

or second bone of the spinal column, which projects upwards through a hole in the atlas and forms a pivot or swivel upon which the head *rotates*, or turns from side to side, the atlas also turning with it.

14. The articular surfaces of bones, or surfaces where the joints are, are always protected from friction by shields

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[1] Bones of spinal column.

of cartilage (articular cartilages), and in the movable joints by the synovial[1] membranes which line their cavities, and which secrete[2] and pour into the joints as it is needed a lubricating substance called the *synovial fluid.* The elas-

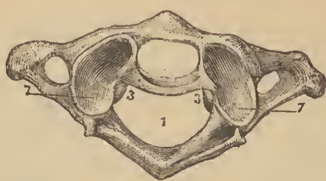

Fig. 8.

The Atlas. 1, opening for spinal cord; 3-3, transverse ligament, enclosing with the bone an opening for part of axis to pass up through; 7-7, resting places for prominences on skull.

ticity of these cartilages serves to diminish shocks from walking, running, jumping, etc., thus protecting the delicate structures of the body from injuries which would otherwise result.

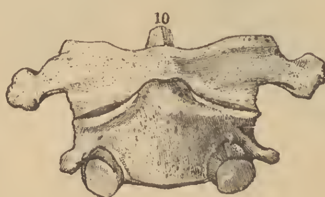

Fig. 9.

Atlas and Axis in position. 10, projection of axis, passing through the atlas, upon which the skull rests.

15. The bones are held together by strong bands of fibrous connective tissue, called *ligaments.* Their connection is further strengthened by muscles and tendons, and

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[1] So called from the synovia or adhesive fluid within it.

[2] *Secretion* is the separation from the blood of certain specific materials, and their storage in secreting glands or reservoirs for special use.

also, in some degree, by the enveloping fat and skin. The accompanying figure represents the structure of joints.

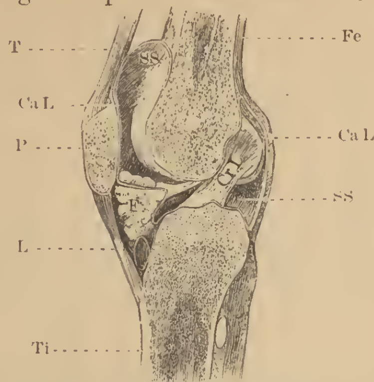
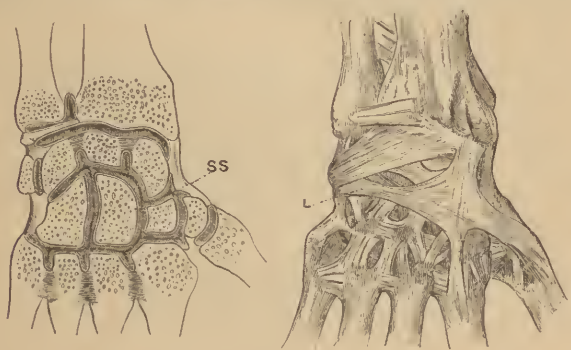


Fig. 10.

Longitudinal section of knee-joint, showing the relation of the structures which enter into its composition. T, tendon; SS, synovial sac; Fe, femur; P, patella or knee pan; L, ligament of patella; F, fat; Ti, tibia; Ca L, capsular or enveloping ligament; Cr L, crucial or cross-shaped ligament between the ends of the femur and tibia.



A Fig. 11. B

A. Longitudinal section of wrist joints, showing the synovial sacs and membranes (see SS). B. Ligaments of wrist joint (see L).

16. A *dislocation* is a "bone out of joint." Certain joints — those of the shoulder, wrist, and fingers, for example — are more liable to dislocation than others. Some healthy, well-developed persons are able to dislocate partially their joints at will, — even the hip, knee, and elbow joints.

QUESTIONS.

1. Of what use are bones?
2. How many are there in the body, and how may they be classified?
3. Describe the long bones, and explain the use of their length.
4. Where are the short bones located?
5. What is the special use of flat bones?
6. Why are there eminences, and why depressions, upon bones; and why openings through them?
7. What is the periosteum, and of what use is it? the cartilage?
8. Of what kinds of tissue are bones constructed? Describe them and their respective uses.
9. What and where is the marrow? the medullary canal? the endostium?
10. Of what are bones composed?
11. Of what different uses are the animal and mineral matter of bones?
12. What diverse effects may either have upon the bones, and why?
13. How do the bones of the young and old differ?
14. How are bones nourished, and what do they contain?
15. What is meant by *assimilation?*
16. What is a joint or articulation, and how are joints classified?
17. How are the nodding and rotating motions of the head effected?
18. What protects the joints from friction?
19. How is the liability of the delicate structures of the body to injury from shocks in jumping, etc., diminished?
20. How are the bones held together, and what is a dislocation?

CHAPTER II.

THE BONY FRAMEWORK, OR SKELETON.[1]

17. The skeleton is beautifully adapted to support weight.[2] It affords surfaces for the attachment of muscles, and thus facilitates the movements of the body. Within it are the delicate vital organs.

18. The main support of the body[3] is the *spinal* or *vertebral column*.[4] (Fig. 1.) It serves not only to bear the weight of the upper part of the body, but maintains it in proper relation with the lower part. Its lower end fits in like a wedge between the hip bones, and unites with them to form the pelvis. The spinal column is composed of 26 bones, 24 of which are vertebrae.[5]

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[1] The skeleton of man is an internal or endo-skeleton; that of the oyster or lobster an external or exo-skeleton. The turtle has both an internal and external framework. The sturgeon, besides an endo-skeleton, has an irregular outer case of superficial bony plates (dermo-skeleton), which enables the fish to swim more safely in search of food among rocks and debris.

[2] At 21 years of age the weight of the human skeleton is about *one-tenth* that of the entire body. It averages about 15 lbs., yet is capable of sustaining great weights, and can at times be subjected to great strains without injury. Dr. Winship, the celebrated athlete, though a small man, could lift a weight of 2500 lbs.

[3] The entire body consists of the head, body or trunk, and the limbs or extremities.

[4] It is commonly called the *back-bone*, as though it were but one bone.

[5] In the neck, or "cervical" region, there are *seven* bones or vertebrae; in the back, or "dorsal" region, *twelve;* and in the loin, or "lumbar" region, *five*. The sacrum and coccyx are sometimes called false vertebrae, for in very early life the first is composed of five rudimentary vertebrae and the second of four. Hence, the number of bones in the spinal column is sometimes stated as 33.

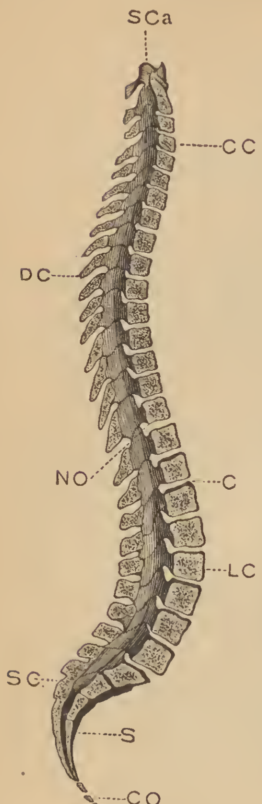

Fig. 12.
Longitudinal section of spinal column. C C, cervical curve; D C, dorsal curve; L C, lumbar curve; S C, saccral curve; S Ca, spinal canal; N O, opening for nerves; C, location of intervertebral cartilages; S, sacrum; C O, coccyx.

19. Each vertebra[1] is composed of a disk-like body, with a bony arch projecting backwards from it, and is tunnelled by a large opening through it, extending up and down, or longitudinally with the body. The vertebrae are united by strong ligaments, and are so placed that the openings through the several vertebrae form one long tube or tunnel, called the *spinal canal*, which serves for the lodgement and protection of the *spinal cord.*[2] To and from this nerves pass, through notched apertures in the sides of the various vertebral arches. The posterior projections (spines) of the arches form the ridge which may be felt extending along the middle of the back. To diminish the shock of jars and falls, there are, between the vertebrae, cushions of very elastic cartilage.

20. The vertebral column has four *curves*, — the cervical, dorsal, lumbar, and pelvic. Two are forward curves, and two backward. These are so nicely adjusted that their

[1] These bones are called *vertebrae*, from the Latin *vertere*, to turn, because they turn or rotate, and also at times incline to a certain extent, in the varied movements of the body.

[2] A cord-like arrangement of nerves (that is, many strands of nerves united together in one cord) which connect the brain with other parts of the body, by means of branches sent out through the spinal openings mentioned in the text.

relative positions are ordinarily maintained, whatever the movements of the body may be. Hence, pressure is better distributed than would be the case if the column were straight. Still, jumping from a height upon a resisting surface, heavy blows or falls, and the prolonged and excessive action of special muscles or groups of muscles, frequently produce spinal deformities and disease.[1]

21. Branching out from each side of the spinal column, in the dorsal region, are the twelve *ribs*, which are grooved underneath for the passage of blood-vessels and nerves to the front of the body. The ribs slope downward and outward, and, with the dorsal vertebrae and breast bone, form the bony walls of the thorax or chest. This arrangement and the elasticity of the cartilages, which unite most of the ribs to the breast bone, permit considerable enlargement of the chest cavity in the process of breathing.[2] Free movements of the chest walls are necessary for the health and proper action of the organs within them.

22. The *pelvis* consists of the sacrum and coccyx behind, the hip bones (innominate bones) upon the sides, and the pubic bone in front. By its size, strength, curves, and expanded upper edges (hips), it is well adapted to

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[1] Spinal curvatures are liable to result from habitual sitting, standing, and even lying in wrong positions. The *habit* of bending over to study, write, or use the sewing-machine is injurious. When standing, the body should be erect, the shoulders held back in an easy, comfortable manner. When sitting, the body or head should be bent but slightly forward. Constrained positions are always injurious.

[2] The seven upper ribs upon each side are called *true* ribs, because they are joined to the breast-bone directly by cartilages; the other five are called *false* ribs, because not so joined, — the two upper being fastened by cartilage to the cartilages of other ribs, while the three lower, which are called "floating ribs," have no cartilages, their anterior ends being free and floating as it were.

support and protect the organs within it. It also assists in supporting the upper part of the body, by its relation to the spinal column and the attachment it affords for the powerful muscles of the trunk. Articulating (that is, forming joints) with the pelvis are the two thigh bones. These are supported by the bones of the legs, which rest upon those of the feet.

23. *The bones of the feet* are arranged in the form of an arch, the forward part of the foot and the heel only resting upon the ground. This arched form secures much

Fig. 13.
Bones of the foot and their relative location.

elasticity, and diminishes the shocks to other parts, in the acts of running, walking, and jumping. It also affords a more secure footing in walking and running over uneven ground, in climbing ladders, etc.

24. Joined to the trunk, at its upper and lower portions, are the *limbs* or *extremities*. The bones of each *upper extremity* (the arm and its appendages) are the clavicle, scapula, humerus, radius, and ulna, and those of the wrist and hand. Each upper extremity is so arranged that the hand, which assists in giving to man his great superiority over the lower animals, may be freely used.[1]

[1] The arm bone is longer than the forearm bones, and the forearm bones than those of the hand. This arrangement, together with very pliable fingers, and with the thumb, which can readily be "opposed" to all the fingers, characterizes man as distinct from and above all other forms of animal life.

25. The *lower extremities* (legs and their appendages) have a strong resemblance to the upper, but have less mobility. The bones of each lower extremity are the femur, tibia, fibula, knee-pan, and the bones of the ankle and toes.

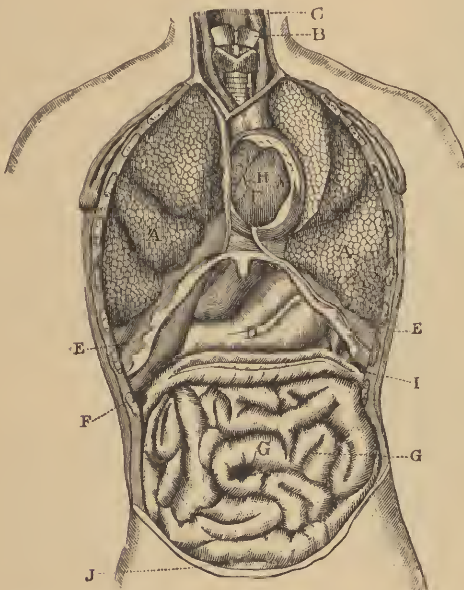

Fig. 14.

Front view of the contents of the cavities of the chest and abdomen. B, trachea; C, œsophagus; E, diaphragm; F, liver; I, spleen; D, stomach; G, intestines; H, heart; A, lungs; J, bladder.

26. There are three principal closed cavities within the skeleton: viz., the *cranial*, *thoracic*, and *pelvic* cavities.[1]

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[1] In addition to these cavities, and the marrow cavities of long bones, there are cavities which contain air, — such as the "frontal sinuses" in the frontal bones of the skull, which open into the upper part of the nose; the antrum, in each half of the upper jaw; and the sphenoidal and ethmoidal sinuses, in the sphenoid and ethmoid bones, etc. These reservoirs of air are concerned in the processes of breathing and the production of voice, and serve to lighten the weight of bones.

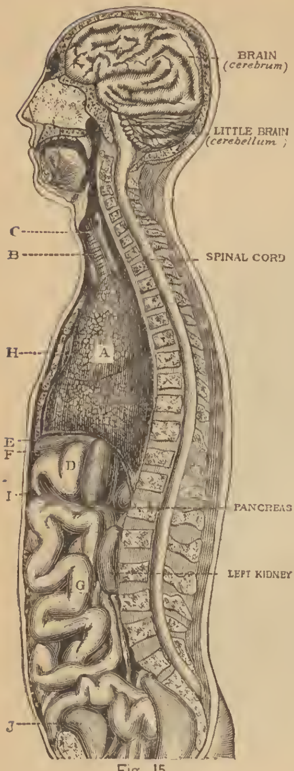

Fig. 15.
Side view of the head and trunk; the bones and soft coverings of the cavities being removed, and the face, throat, and spinal column given in longitudinal sections. The organs are in relief. A, lungs; B, trachea; C, œsophagus; D, stomach; E, diaphragm; F, a small portion of the liver; G, intestines; H, heart; I, spleen; J, bladder.

27. The *cranium*, or *skull*, is a rounded bony box, admirably constructed for its particular use.[1] It has a vaulted dome, side walls, and very strong buttresses in the temporal bones which enclose the delicate organs of hearing. The base is formed of bones strongly wedged in together, with openings so arranged that the delicate blood-vessels and nerves passing through them are not easily injured. Within the cranial cavity are the brain and the commencement of the spinal cord, and also nerves and blood-vessels.

28. The *thoracic cavity* extends from the base of the neck above to the diaphragm[2] below, and from the spinal column and ribs behind to the breast bone and the cartilages of the ribs in front. It contains the lungs, heart, some large blood-vessels, nerves, the thoracic duct, and œsophagus or gullet.[3]

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[1] The tissue of the flat bones, of which it is composed, is arranged in layers or "tables." On account of their character, these were by the Ancients likened, the outer one to *wood*, the middle one to *leather*, and the inner one to *glass* (from its smoothness).

[2] A strong muscular and tendinous partition dividing the thoracic from the abdominal cavity. (See Fig. 14.)

[3] The lungs fill the larger part of the cavity.

29. The *pelvic cavity* is the space enclosed by the pelvic bones.[1] There is a fourth cavity, the *abdominal cavity*, which is partly enclosed by bony walls and in part by muscles. It is located between the thoracic and pelvic cavities, and contains the liver upon the right side, the stomach and spleen on the left, the intestines in front, and the pancreas, kidneys, receptacle for chyle, and very large blood-vessels and nerves behind.

QUESTIONS.

1. Of what service is the skeleton?
2. What is the main support of the skeleton, and its use?
3. How is the spinal column fitted to the hip bones, and of what does it consist?
4. Describe the vertebrae, and how they are separated from each other, and why.
5. How is the spinal canal formed, and what is its object?
6. How do the nerves of the body reach it?
7. What curves has the spinal column, and what is their object?
8. Describe the ribs, and explain the object of their downward slope.
9. Of what bones does the pelvis consist, and what is its use?
10. Describe the lower portion of the skeleton.
11. How are the bones of the feet arranged, and why?
12. Of what bones does each upper extremity or arm consist, and what is the object of their arrangement?
13. What are the bones of the lower extremities, or of each leg?
14. What cavities are in the skeleton?
15. Describe the cranium, and mention its contents.
16. Describe the thoracic cavity, and mention its contents.
17. What cavity is above the pelvic cavity, and what are its contents?

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[1] Its contents are the bladder and other viscera.

ANALYSIS OF CHAPTERS FIRST AND SECOND.

BONES.

- I. ANATOMY
  - 1. Classes
    - Long.
    - Short.
    - Flat.
  - 2. Structure
    - Compact tissue.
    - Spongy tissue.
    - Periosteum.
    - Endostium.
    - Marrow.
    - Vascular canals.
    - Canaliculi.
    - Lacunae.
  - 3. Joints
    - Classes
      - Movable.
      - Immovable.
      - Mixed.
    - Cartilages.
    - Ligaments.
    - Synovial sacs.
    - Synovial fluid.
  - 4. Arrangement in skeleton
    - Skull.
    - Spinal column.
    - Ribs.
    - Breast bone.
    - Pelvis.
    - Extremities
      - *Upper.*—Bones of shoulder, arms, forearm, and hands.
      - *Lower.*— Bones of thighs, legs, and feet.
  - 5. Cavities
    - Cranial.
    - Thoracic.
    - Pelvic.
    - Abdominal.
- II. PHYSIOLOGY
  - 1. Uses
    - Columns of support.
    - Act as levers.
    - Enclose cavities.
  - 2. Nutrition
    - Through blood-vessels.
    - Through nerves.
    - Through lymphatics.
- III. HYGIENE
  - 1. Maintenance of health
    - By proper exercise, rest, nourishment, etc. See especially chapters on Food and Foods.

CHAPTER III.

MUSCLES AND FAT.

30. The muscles, about 400 in number, are the direct instruments by which the *movements* of the several parts of the body are effected. They are of a deep-red color,[1] and constitute what is ordinarily called "flesh," or, in animals, "lean meat." They are grouped about the bones, to which many of them are attached. They also form a part of the walls of many organs,—as the stomach, heart, intestines, and blood-vessels.

31. Muscles have different *shapes*, and are *arranged* mainly in layers from within outward, occupying always the best position to facilitate their action and preserve the compactness, usefulness, and beauty of the parts. Those of the face are, for the most part, short and narrow; of the cranium, thin and flat; of the thorax, abdomen, and pelvis, broad and flattened; and of the neck and extremities, long and rounded.

32. The muscles grouped in the above-mentioned localities are known as *voluntary muscles*,[2] because their movements are, for the most part, governed by the will. The internal muscles of the body are generally thin and

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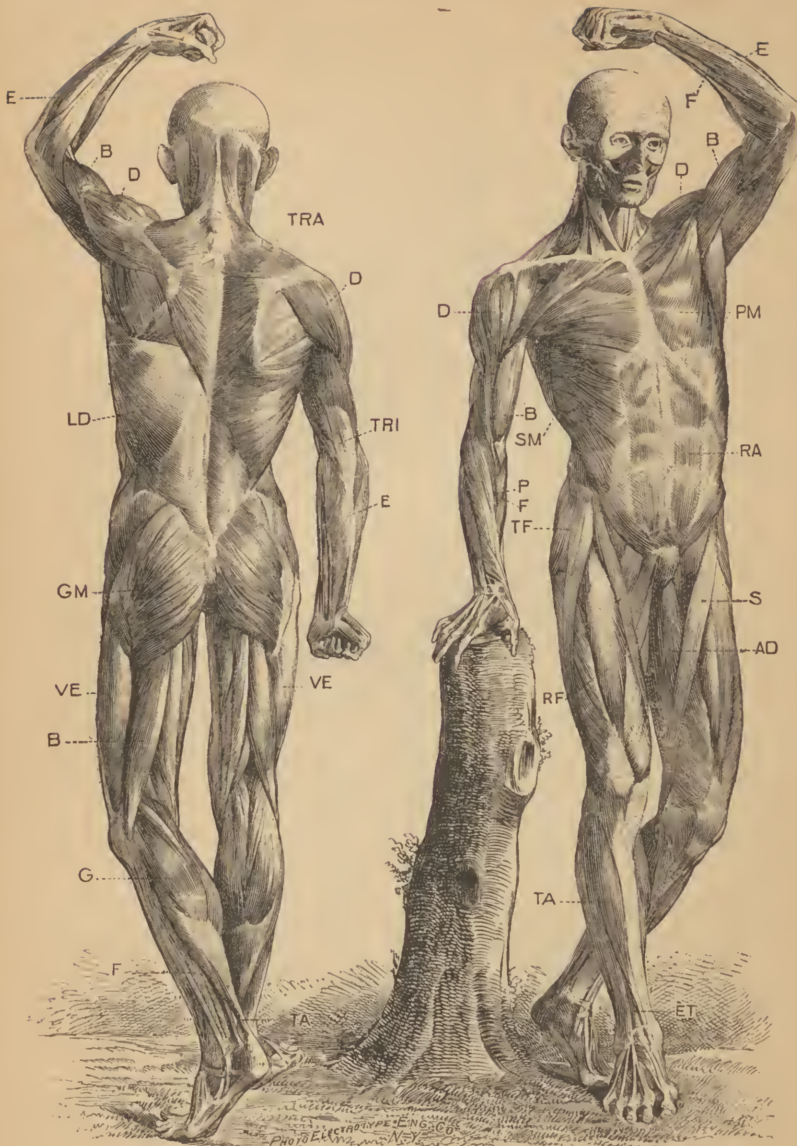
[1] Muscles but little used, as in young children and paralyzed persons, have a pale color. In most of the vertebrate animals the flesh is red. In some birds and many fishes it is colorless, yellowish, or pink.

[2] Also as "muscles of animal life," or "skeletal" muscles.



A. — Posterior view. B. — Front and side view.

Fig. 16.

Fig. 16.

Muscles of the Body. *Superficial layer.*

A.

E, extensors of the hand.
B, *biceps* muscle, flexor of arm and forearm.
D, *deltoid*, raises the arm and moves it backwards and forwards.
TRA, *trapezius*, draws back and raises shoulder.
TRI, *triceps*, extensor of forearm.
LD, *latissimus dorsi*, assists in respiration by moving the ribs.
GM, *gluteus maximus*, moves the thigh backward and outwards.
VE, *vastus externus*, extends the leg.
B, *biceps* of thigh, flexor of leg.
G, *gastrocnemius*, extends the foot.
F, flexors of the foot.
TA, *Tendo Achillis*.

B.

E, extensors of the hand.
F, flexors of the hand.
B, *biceps*, etc.
D, *deltoid*, etc.
PM, *pectoralis major*, draws the arm forwards and inwards.
P, *pronator*, rotates forearm inwards.
SM, *serratus magnus*, assists in respiration.
RA, *rectus abdominis*, that makes tense the abdominal walls.
TF, *tensor femoris*, that makes tense the connective tissue of thigh, and moves the thigh outwards.
S, *sartorius*, flexes the leg.
AD, adductor group of thigh muscles.
RF, *rectus femoris*, one of the group of extensor muscles of thigh.
TA, *tibialis anticus*, moves foot forwards.
ET, extensors of the toes.

flat, and are *involuntary*, discharging their functions independently of the will. For instance, the simple presence of food in the stomach is sufficient to excite that muscular organ into its normal and involuntary activity.[1]

33. Voluntary muscles are connected with bones, and also with cartilages, ligaments, skin, and other structures. This connection is effected either by muscular tissue, or by means of white, firm, glistening masses of fibrous tissue, known as *tendons*, or sinews.[2] The latter are flexible and inelastic, and are especially required to serve the purpose of connecting bands or cords, where the parts of the body to be moved are remote from the moving muscles. They thus obviate an unnecessary, ungainly, and sometimes impossible prolongation of the muscles,[3] and conduce to the symmetry and beauty of outline of the body. But for this simple adaptation, how bulky and ill-proportioned, for example, would be the wrists and ankles, through which, instead of the muscles, these slender cords are made to pass; and how clumsy the movements, which by their means are accomplished with such efficiency, rapidity, and grace! (*a.*) The strongest and largest tendon in the body is the "Tendo Achillis," which

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[1] By some authorities certain muscles are called *mixed muscles*, because they belong partly to the voluntary and partly to the involuntary classes. Such are the muscles of respiration, or breathing. Ordinarily, we breathe without exertion of the will, but to a certain extent it is in our power to increase or suspend the process. "The muscular fibre of the heart presents a structure intermediate between the two typical forms."—*Manual of Histology*, SATTERTHWAITE.

[2] This fibrous tissue, in the form of a very resisting membrane, is continuous with the muscular tissue of some muscles, and envelopes others, preventing their displacement. It is then called an *aponeurosis*, from the belief of the ancients that it was a membrane of nervous tissue.

[3] The tendon of one of the muscles which moves the eye passes through a loop or pulley. A tendon under the jaw passes through a slit in the tendon of another muscle whose direction is different.

connects certain muscles on the back of the leg with the heel.[1] Involuntary muscles, for the most part, are not attached to bones, but to other structures.

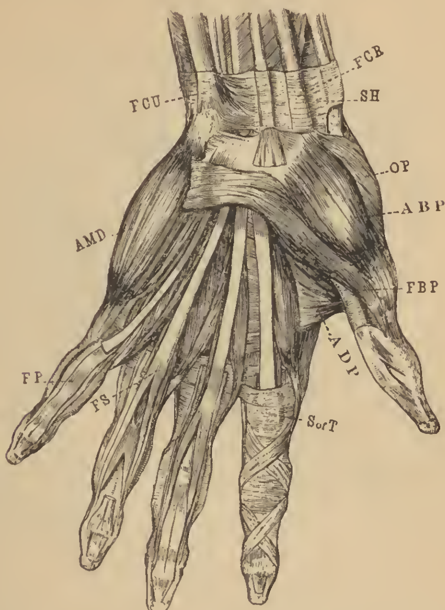

Fig. 17.—MUSCLES OF LEFT HAND. *Front surface.*

FCU, flexor of ulnar side of the wrist; FCR, flexor of radial side of wrist; SH, sheath of connective tissue through which the tendons pass; OP, the opposing muscle of thumb; ABP, muscle that draws the thumb outward; FBP, the short flexor of the thumb; ADP, adductor that draws the thumb inwards; S of T, sheath of tendon in position, removed from other fingers to show the arrangement of tendons; FS, long, superficial flexor of the fingers; FP, the long, deep flexor of the fingers; AMD, that pulls the little finger outward.

34. Voluntary muscles are made up of *bundles of fibres.* Each fibre is tightly enclosed by a structureless membrane, called *sarcolemma*, which is very elastic, and

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[1] So called (the Tendon of Achilles) from the Grecian fiction, that this tendon was the only vulnerable portion of the body of Achilles.

Tendons may be readily felt at the wrists, ankles, the bend of the elbows, and under the knees, especially when the muscles are tense.

allows of the free movements of the fibre. The several bundles of fibres are surrounded, as is also the entire

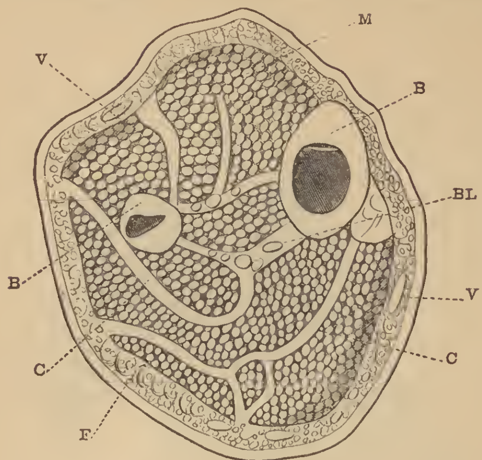

Fig. 18.
Traverse section of a leg.— B, bone; C, connective tissue; F, fat (adipose tissue); V, veins; M, muscles; BL, blood-vessels (arteries and veins).

muscle, with connective tissue, holding together the fibres in each bundle, and the several bundles into the one muscle.

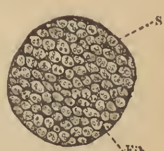

Fig. 19.
Cross-section of a fibre of voluntary muscle, magnified.— S, sarcolemma; Fib, fibrillae.

"Each fibre is divided longitudinally into a varying number of what are called *muscle columns*, held together probably by a delicate cement."[1] The muscle columns are called by some *fibrillae* (little fibres).

A muscular fibre of a voluntary muscle, under the microscope, is shown to have alternate dark and light cross stripes, or *striae*. Hence, voluntary muscles are also known as *striated*, or *striped*.[2]

---

[1] *Satterthwaite's Histology*. Dr. Thomas Dwight.

[2] These transverse stripes are by some authorities believed to be the boundary lines of muscle cells in each muscle column, while others believe

Involuntary muscles are also composed of fibres, but these are spindle shaped, and unstriped, and form tissues by the interlacing of the fibres.

35. Muscles are abundantly supplied with *blood.* Between and beneath the muscles are large blood-vessels, whose smaller branches pass between the fibres. These blood-vessels are accompanied by *nerves.* The nerves of voluntary muscles are chiefly motor nerves, or those which preside over motion, while a great part of those of involuntary muscles are sensory

Fig. 20.
A portion of a voluntary fibre, showing the fibrillae, transverse striae, and the sarcolemma detached at one point. Magnified 250 diameters.

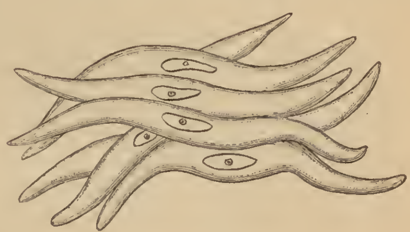

Fig. 21.
Non-striated fibres of involuntary muscles, somewhat separated from each other for microscopic examination.

nerves, or those which preside over sensation. Fat cells are sometimes found amoung muscular fibres.

36. The fibres of living muscle tissue are *composed* of a translucent jelly-like material, sometimes called *muscle plasma.* Three-fourths of this muscle plasma is water; the remaining fourth is composed of common salt, calcium

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that they represent transverse disks of the width of the fibre; others still, believe that the so-called cells and disks are not found during life, but that they result from changes after death.

phosphate,[1] albuminous material (*i.e.*, like albumen, see §159), and extractive matters.[2] The principal ingredient, water, gives to muscles their softness and flexibility.[3]

37. Muscles are essentially *organs of motion.* On account of their location and arrangement, they also *shield* blood-vessels, lymphatics, and nerves; serve to *diminish the force of shocks and blows;* and, in connection with the bones, *enclose the cavities* of the thorax, abdomen, and pelvis. By means of muscles the varied and wonderful movements of the body are performed, and speech is rendered possible. Through the action of muscular fibres the heart pulsates, the blood circulates, and respiration, digestion, and the other vital processes are carried on.

38. These muscular movements result from the *contractility of muscular tissue.* This property of shortening and thickening their bulk when tense, or in a state of action, and of becoming elongated and thinner when relaxed, or in a state of rest, is peculiar to muscle fibres, and is sometimes spoken of as muscular irritability. Contractility is normally excited in voluntary muscles by the will acting through the nervous system, but it can be called into action also, independently of the will, by various kinds of stimulation, — such as pinching, pricking with a needle.

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[1] Formerly called "phosphate of lime."

[2] Ingredients in 100 parts of muscle plasma: —

Water	75.00
Albuminous material	22.00
Extractive matters	2.55
Calcium phosphate	.25
Common salt	.02
	100.00

[3] Where, in certain diseased conditions, or from overwork, the fluids of the body are diminished, certain muscles in motion produce creaking sounds as their tendons pass through grooves or canals. As soon as death occurs, muscles begin to be rigid.

the application of an acid, electricity, etc. In involuntary muscles, it ordinarily results from nervous stimulus.[1] Contractions may be extremely gentle, as when the muscles of the eye or hand are engaged in delicate work; or they may be powerful, as in athletic sports or in heavy lifting. Prolonged use of muscles, the want of use, a supply of poor or insufficient blood, certain poisons, etc., lessen their normal irritability.

39. The respective groups of muscles are named according to the kind of motion produced, their position, uses, etc.[2] Muscles that bend the joints are called *flexors*, — as, for example, those on the front of the arm that bend the forearm, and on the back of the thigh that bend the leg. Those which restore the bent parts to a straight condition are *extensors*. The extensors corresponding to the above-mentioned flexors are located, as the necessity of the case demands, on the back of the arm and the front of the thigh. *Rotator* muscles are those "which turn the parts to which they are attached upon their axes." Such are the oblique muscles of the eye and those attached to the radial bone of the forearm. It is by means of the latter that the forearm and hand can be turned round so as to present either side at pleasure.

Adductors are muscles which move parts toward the axis of the body, and *abductors* those which move parts from the axis of the body. Of the first, the large muscles

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[1] Muscles are also elastic, and are said to have "tone" when they promptly, and in a normal manner, respond to stimuli.

[2] It is not the purpose of this book to weary the student with the technical appellations which have come down to us from the Ancients. Their length is often in inverse proportion to the size of the muscle named. For instance, a very short muscle which extends from one corner of the upper lip to the nostril upon the same side of the face, whose function is merely to raise the lip, as in sneering, is called the "levator labii superioris alaeque nasi," while a very long and important muscle of the thigh is more plainly named the "sartorious," *i.e.*, the "tailor," because it is the principal muscle by which that useful functionary assumes his familiar position for work.

of the chest and back which draw the arm to the side, and those which draw the lower extremities together, are examples; of the latter may be named the muscles of the shoulder, and the outer muscles of the thigh.

Sphincters are annular muscles, which close or constrict certain natural openings of the body, as the eye and mouth.

40. Muscles, such as the flexors and extensors, the abductors and adductors, which produce by their action entirely opposite movements, are called *opposing* or *antagonistic.* The result of the combined action of opposing muscles, when excessive, is rigidity. It is the easy combined action of the opposing muscles which enables us to stand, or to apply a force properly gradnated to the necessities of the most delicate muscular work. (*a.*) The action of opposing muscles, when healthy, is nicely adjusted, so as not to interfere with their mutually free and easy movements. Their abnormal action is exemplified in the rigidity which takes place in convulsions, and in "lead palsy," where the unchecked contraction of the flexors of the forearm, through paralysis of its extensors, produces a falling of the hand known as "wrist drop."

41. There are also what are termed *the muscles of expression.* Ordinarily, we show how we feel by our features, and the position and movements of the body. The expression of the emotions is effected mainly, however, by the varied movements of the facial muscles, especially those which move the lips, eyelids, eyebrows, etc., and of the muscles which move the lower jaw. Hence these muscles are spoken of as the "muscles of expression."[1]

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[1] It is stated by Dunglison that there are 70 pairs of muscles in the neck and face; and it has been estimated that the body is capable of 5000 different movements, and the face of 750 different expressions.

42. For the healthy growth and development of muscles, *alternate exercise and rest are indispensable.* Over-worked muscles, equally with idle muscles, waste away; and, in the latter case, useless fat may take the place of the muscular fibres. Healthy muscles, therefore, require a constant supply of good blood, sufficient nerve stimulus,

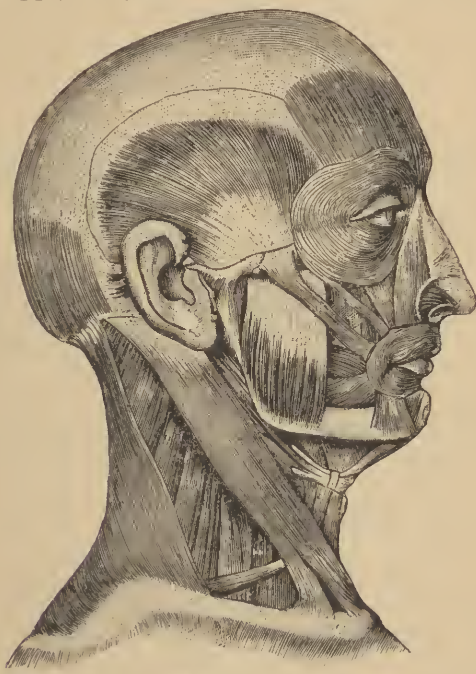

Fig. 22. — Muscles of Expression.

and proper exercise and rest. Without these requisites, waste products (principally carbonic acid) accumulate, and muscular activity is diminished. In the arrangement of nature, certain muscles are intended to be at rest while others are in activity. Even the fibres of a single muscle do not all act at the same time. This provision does not dispense, however, with the necessity for additional rest in sleep.

43. All parts of the body, the brain included, require rest, and share directly or indirectly in the *benefits of sleep*. (*a*.) Particularly refreshing is the early portion of sleep, and that which is least disturbed by uneasy dreams, mental effort, and anxiety. Generally, the more both mind and body can be withdrawn from all extrinsic stimuli the better. The amount of sleep needed by different persons varies according to the age and condition of individuals. The greater part of infancy is generally passed in slumber; and in old age also much sleep is required. In middle life, usually, about eight hours a day is necessary, though it is reported of Frederick the Great and Napoleon that they slept but three or four hours out of the twenty-four. (*b*.) Needed restoration is to be often sought in a *change of employment*, whether of work or amusement, as well as in sleep. In such cases, if amusement be needed, it becomes as much one's duty to play as before it was to work.

44. Fat. — This substance usually constitutes about one-twentieth part of the weight of the entire body. It is found in all parts of the body, with the exception of the bones, teeth, and fibrous tissues, either in the form of globules and granules of oil, or of an emulsion,[1] or is in masses. In the latter form it is called *adipose tissue*, the most familiar example of which is that which is imbedded in the areolar or connective tissue, between the skin and the muscles.

Animal fat is generally a mixture of three varieties of fat, — stearine, margarine, and oleine. Stearine and margarine are more or less solid, as usually seen in the meat of animals; but in the live body, at its ordinary temperature, they are held in solution by the oleine with which they are associated.

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[1] That is, in suspension, as in milk.

45. By the arrangement of the fat about the internal organs, between the muscles, under the skin, and about the joints, it *acts as cushions* to these structures, *maintains their temperature*, *fills up inequalities* in and about the various structures, and greatly *enhances the beauty and symmetry* of the human form. It also *serves for nutrition* in time of need, as is particularly to be observed in torpid animals[1] and in emaciating diseases. In fact, fat being composed of carbon, hydrogen, and oxygen, contains ele-

Fig. 23.
AT, adipose tissue; C, fat in cells of cocoanut, as viewed through the microscope.

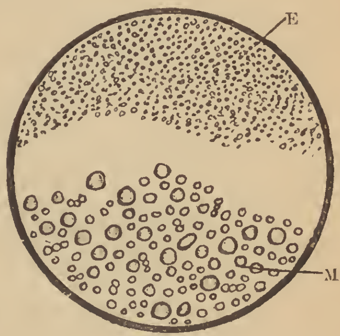

Fig. 24.
M, fat globules in milk; E, fat globules in an emulsion. Microscopic view.

ments which are essential to the nutrition and growth of tissues, and is found in quantity whenever cell growth is rapid, especially in the case of healthy young children.

46. The *amount of fat* in different persons depends upon age, race, and hereditary tendency; also upon the weather, climate, and occupation; yet there is probably a normal limit as to the amount of fat in the case of each individual.

[1] The common tortoise, for instance, burrows in the earth in the latter part of autumn, and does not reappear till spring has well advanced. Some species of bears become very fat toward the winter time; and then, during the winter, while hibernating, eat no food, as far as is known. In the spring they come out of their hiding-places, lank and hungry.

Any amount beyond this limit is likely to be not only inconvenient, but distressing and even dangerous to life, either by impeding the action of the heart or by taking the place of important tissues, thereby producing a diseased condition which is known as "fatty degeneration."

Ordinarily, a steady gain of fat within the normal limit indicates an improving condition of the blood and better nutrition, while a deficiency is often the first note of alarm to warn us of the approach of consumption, scrofula, or some other serious disease which has begun its stealthy march in a faulty nutrition.[1] Rapid loss of fat usually indicates impoverishment of the blood.[2]

47. "Fatty tissue is the most *fluctuating in bulk* of all the tissues of the body," for within a very short time a large amount may appear or disappear. Its *increase* is promoted by many of the animal and vegetable substances used as food, and it is the result also of chemical changes that occur in the body in such food as starch and sugar. It is often injuriously increased by impoverished blood during sickness or idleness, by a continued use of alcoholic drinks (especially ale, beer, and porter), and by fatty, sugary, and starchy foods. It may be, therefore, *diminished* sometimes by a partial or complete omission of the

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[1] It has been observed that cooks, butchers, oilers, etc., are generally exempt from such affections, and it is believed by some authorities that the exemption is due to the fat absorbed by their skins from the materials which they handle.

[2] Sometimes, in emaciating diseases, or as the result of excessive alcoholic stimulation, the oleine partially disappears from the adipose tissue, and is replaced by watery serum, as it is called. "There is a popular idea," says Dr. S. Weir Mitchell, in his valuable little treatise (*Fat and Blood, and How to Make Them*), "which has probably passed from the agriculturist into the common mind of the community, to the effect that human fat varies, — that some fat is wholesome and some unwholesome; that there are good fats and bad fats. I remember well an old nurse who assured me when I was a student that 'some fats is fast and some is fickle, but cod-oil fat is easy squandered.' There are more facts in favor of some such idea than I have space for; but as yet we have no distinct chemical knowledge upon the subject."

articles of food and drink mentioned above, also by proper bathing and attention to the excretory organs, and by systematic, well-adapted exercise. It can seldom, with safety, however, be kept below the individual's normal standard for a great length of time. The use of drugs or medicines as anti-fat remedies are not always safe, nor are they generally efficacious.

QUESTIONS.

1. Describe muscles.
2. What is their chief use?
3. What two grand divisions of muscles are there?
4. How are muscles attached to the parts to be moved?
5. Why are tendons used for this purpose?
6. Why are the voluntary muscles more often attached to bones than the involuntary?
7. Why do blood-vessels and nerves accompany muscles?
8. What is the chief constituent of muscle substance?
9. What other uses have muscles besides being organs of motion?
10. To what is the moving power of muscles due?
11. How may the contractility of muscles be excited?
12. How may their irritability become weakened?
13. What are opposing or antagonistic muscles? Give examples.
14. What are the respective results of their normal and abnormal action?
15. Name other sorts of muscles.
16. What are the muscles of expression?
17. What is necessary for muscles to be healthy and well developed?
18. When is sleep most beneficial?
19. What periods of life require most sleep?
20. How may muscles be refreshed without cessation of activity?
21. What are the varieties of fat?
22. What its uses?
23. How does excessive fat become dangerous?
24. How may fat be increased? how diminished?
25. What about the use of drugs to that end?

CHAPTER IV.

MUSCULAR EXERCISE.

48. *Physical culture* has engaged the attention of mankind, in a varying degree, from the very earliest times. Its *object*, at first, was to strengthen man for defense against his fellow men and wild animals. At a later date, in the Grecian games, athletic contests were eagerly entered into in a spirit of emulation, and for the cultivation and exhibition of strength and beauty. Among the Spartans the women, as well as the men, had their physical training. And yet, we are told by the medical writers of those times that the excessive exercise indulged in by many of the athletes rendered them "dull, sluggish, and torpid, and that they only averaged five years of (athletic) life." Still later, in the gymnasia, or schools of the Greeks, efforts were first made to combine physical and mental education, so as to produce "a sound mind in a sound body." Yet, even at the present time, the true value of proper muscular exercise in restoring, as well as in maintaining health, is not fully appreciated. The primary effect upon the system of proper exercise, as we have already seen, is to insure the health, strength, and tonicity of muscles; and secondarily, by means thereof, the health of the other tissues of the body.

49. *Proper muscular exercise* is that which is suited to the health and strength of the individual. It should be varied and agreeable in character, and pursued daily,

either in the open air or in well-ventilated places, but never to the point of weariness. Exercise — walking, for example — which is systematically undertaken merely for the sake of exercise, is not only irksome, and likely to be suspended after a time, but is not as beneficial as when it is associated with an agreeable visit, beautiful scenery, the gathering of flowers and shells, or even the purchase of some desired object.[1]

50. Exercise, besides *developing and strengthening the muscles*, causes a muscular pressure upon the blood-vessels, and *increases the force and rapidity of the circulation*, thus promoting the consumption of oxygen[2] by the tissues, and the elimination from them of carbonic acid and other waste products. Through exercise the *breathing power is developed, the appetite improved, digestion made stronger, the accumulation of fat diminished*, and *animal heat increased*. The nervous system also shares in the general improvement, and, as a consequence, *better mental work is made possible*.[3] In those colleges and schools where physical culture is attended to, the mental as well as the physical strength of the students has been found to be improved. (*a*.)

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[1] "I have heard that that benevolent nobleman, Lord Rosse, during the famine years, anxious to relieve distress, and equally anxious not to encourage habits of pauperism, paid men so much a day for digging holes in his demesne, and paid them again for the filling of them up. The laborers are said to have manifested the most extreme disgust at the occupation, although the work was not harder than most useful labors. It is this sense of the inutility of the work done by the labor in some of the military prisons which constitutes much of the severity of the punishment. And this remark is as true of mental exercise as of bodily." — *Lectures on Public Health*. MAPOTHER.

[2] The vivifying principle of the atmosphere which reaches the blood and the tissues through the lungs.

[3] "Those nations have shown the most intellectual strength who have exhibited the most physical stamina." — DR. BEDDOE, in a paper on the *Stature and Bulk of Man in the British Isles*.

51. In fact, in all cases, there should be as much as possible a *corresponding development of the whole man.*[1] Engravers, telegraph and sewing-machine operators, tailors, shoemakers, and all persons who, in plying their vocation, use one set of muscles mainly, are liable to paralysis of those muscles. (*a.*) Such persons should, each day, engage for a time in exercises that will call into action the other muscles of the body. In like manner, those whose callings lead them to the exercise of their brains only, to the neglect of their muscles, make too large a demand upon the nervous system, and pay the penalty in disorders of that system.

52. The *powers of endurance* of individuals are very unequal. Accordingly, what would be proper exercise for one person may be very improper for another. Some feeble persons are too ambitious and need restraint, as much as the lazy need urging. Exercise attended by severe or sudden strains upon undeveloped muscles, or that is beyond the strength of the individual, or of a kind to which he is unaccustomed, will be followed by bad results, — for example, by exhaustion, cramps, loss of appetite, overstrained heart, and even diseases of the blood-vessels and nervous system. (*a.*) The hard work necessitated by certain occupations of life often produces serious results, even in very strong and well-developed

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[1] Large persons with powerful muscles, but with little endurance, are not able to accomplish as much as wiry small ones, whose powers of endurance have been developed by gradual training. "A man of good physical capacity may be trained so that the voluntary muscles of his arms and chest would be powerfully developed with a contractile force proportionate to their size, and yet his respiratory power shall be so disproportionate that he could not run a hundred yards without gasping; and another, or the same individual, if possessing ordinary locomotive capacity and fair development, may be trained to run ten times the distance without distress, but the voluntary muscles of whose arms and chest shall remain as they stood at the time that the training began." — *Training in Theory and Practice.* McLaren.

men. It is especially important that such occupations should be carried on in the open air, or in well-ventilated rooms, and that the workers should have the proper kind and amount of food. Attention to these details would undoubtedly save the lives, especially of many young men and women.

53. Young children, even babies, should not be carried more than is absolutely necessary. They will exercise themselves sufficiently if placed in warm but well-ventilated rooms, where the limbs can have free movements, unimpeded by tight or heavy clothing. Childhood, indeed, is a period of restless activity, and by the time a child is three years old *systematic exercise* becomes necessary. Gentle walks, running after and throwing balls, playing with clean sand, and the like, should be regularly permitted and encouraged. Much harm is caused by confining young children and putting barriers around their natural desires for play. In the case of older children and youth, no system of artificial exercise can take the place of that afforded by the usual out-door games, such as base ball, foot ball, leap frog, hoop rolling, hare and hounds, etc., always provided they are not played too roughly or continued too long. These sports may be pursued advantageously, as a rule, up to forty or forty-five years of age. At about this age natural degenerative changes occur in the body, and care is particularly necessary that the heart and blood-vessels be not overstrained. Hunting (if moderate), fishing, etc., are more suitable to this period of life. At sixty and upwards exercise continues necessary; but the tissues having become still weaker, it should be very gentle in character.

54. There is no physiological reason why *girls*, instead of being limited to a round of spiritless games which are

of very little use in developing strength, quickness of motion, and the power of endurance, should not engage in many of those sports which are the delight of boys. (*a.*) The opportunities for out-door exercise by girls and women are, unfortunately, not so many nor so diversified as for boys and men. In a few cities, however, a change for the better has been effected, and out-door sports are encouraged in the large parks and pleasure grounds. Sedentary habits are especially the bane of women in prosperous circumstances. It sometimes happens, therefore, that the loss of wealth, by bringing with it the necessity for exertion, and a consequent restoration to health, proves a blessing in disguise.[1]

55. The early part of the day, — not immediately on rising, however, but after the system has been toned up by some slight food and preliminary gentle movements, — is the *best time* for hard work or exercise; for then the body has had the benefit of the rest of the previous night. It is not safe to exercise violently either soon after eating heartily or upon an empty stomach, or when the body is in a state of exhaustion. At one time it was commonly believed that a long walk before breakfast was especially desirable; but the bad results following this exercise, in many instances, such as exhaustion, faintness, dyspeptic and nervous disorders, have served to dispel the idea among careful observers. The gentle nervous stimulus

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[1] It has been estimated that the average woman, in her work about a house, each day exerts as much muscular force as would be expended in walking two and a half miles, but that her proper exercise should, in fact, be equal to a walk of six miles a day. It is stated that English women frequently walk eight to eleven miles a day. Some women, however, though in good circumstances, insist upon doing more daily work than a walk of eight to eleven miles would represent. These women, and those who are poorly fed and obliged to overwork, seldom have healthful recreations, and sooner or later break down.

given to the whole system by a little light food in the stomach after its long fast is needed by the majority, and would be beneficial to all, before exercising in the early morning.

56. *Varieties of Exercise.*—The different forms of exercise may be *classified* as follows: 1st. Those that bring into nearly equal action *all* the muscles of the body, as swimming, horse-back riding, archery, fencing, base and foot ball, lawn tennis, military drill, etc. 2d. Those that exert the muscles of the *upper* part of the body principally, as billiards, rowing, bowling, shooting, croquet, etc. 3d. Those that serve to develop principally the muscles of the *lower* part of the body, as walking, dancing, skating, bicycle riding, etc.

Most of these exercises are beneficial to both sexes. As respects the one first above-named, certainly every one should learn how to swim. Apart from its utility as a safeguard to life, it is the experience of one of the large swimming schools in London, that carefully regulated swimming develops muscle, and relieves to a great extent "backache," or pain in the lumbar muscles. Horse-back riding also is a valuable form of exercise. As Dr. Holmes expresses it, "Saddle-leather is in some respects even preferable to sole-leather; the principal objection to it is of a financial character." So, too, gentle rowing in a good boat not too heavily laden, walking, lawn tennis, and archery, are very desirable exercises. (*a.*)

57. A *gymnasium* is valuable for those persons who do not have opportunities for out-door exercise, or who need the stimulus of class instruction and the companionship of fellow-workers, accompanied with systematic drill. But too often competition is carried so far that the weak are injured. To effect the most good, the gymnasium should

have a medical superintendent, in order that scholars may not be taxed beyond their strength, and the exercise may be adapted to the individual; that proper ventilation may be maintained, and other hygienic rules observed; and that assistance may be promptly given in case of accidents. For persons who cannot leave their houses, various appliances, such as dumb-bells, Indian clubs, rowing machines, and rubber bands or cords are beneficial.[1]

58. Persons too feeble to use their own muscles in exercise will obtain benefit from carriage riding, the use of electricity, or the gentle, daily rubbing, pressing, and moving of their muscles by another. This last procedure is known as *massage*, and is every day becoming more popular with invalids. Where the will is but slightly, if at all exerted, as in the above examples, the exercises are known as *passive*.

QUESTIONS.

1. What have been the motives for physical culture in the past; and by what bad effects was excessive exercise said to have been followed?
2. What are the effects of, and what is proper exercise?
3. How does it affect the mental health, and why?
4. What is improper exercise, and what are its effects?
5. What is to be said of exercise at different ages?
6. What of the exercise of females?
7. What of exercise in the early morning?
8. What of the varieties of exercise?
9. What of the gymnasium?
10. What is *massage*, and when is it to be employed?

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[1] Much good can be accomplished with these appliances, if they are *properly used;* and, for that matter, quite a gymnasium may be fitted up in a private house at a moderate cost.

ANALYSIS OF CHAPTERS THIRD AND FOURTH.

MUSCLES.

- I. ANATOMY
  - 1. Number.
  - 2. Appearance.
  - 3. Arrangement
    - Superficial.
    - Deep.
  - 4. Attachment . .
    - By muscle.
    - By tendon.
  - 5. Kinds . . . .
    - Flexors and extensors.
    - Abductors and adductors.
    - Rotators.
    - Sphincters, etc.
    - Muscles of expression.
  - 6. Structure . .
    - *Voluntary* — Fibres & fibrillae
    - *Involuntary* — Fibres . . . . . .
      - Composed of water, common salt, calcium phosphate, albuminous matter, and extractive matter.
  - 7. Associated structures . .
    - Tendons.
    - Blood-vessels
      - Arteries.
      - Veins.
    - Lymphatics.
    - Nerves
      - Of motion.
      - Of sensation.
    - Fat.
- II. PHYSIOLOGY
  - 1. Properties . .
    - Contractility.
    - Sensibility.
    - Tonicity.
    - Elasticity.
  - 2. Uses . . . . .
    - As motors.
    - As walls of protection.
    - As aiders of vital processes.
    - To give beauty of outline.
- III. HYGIENE
  - 1. Nutrition.
  - 2. Exercise . . .
    - Amount.
    - Time.
    - Manner.
    - Kind.
  - 3. Rest . . . . .
    - In sleep.
    - In amusement.
    - In change of work.

FAT.

Quantity. Location. Uses. Sources. How increased and diminished.

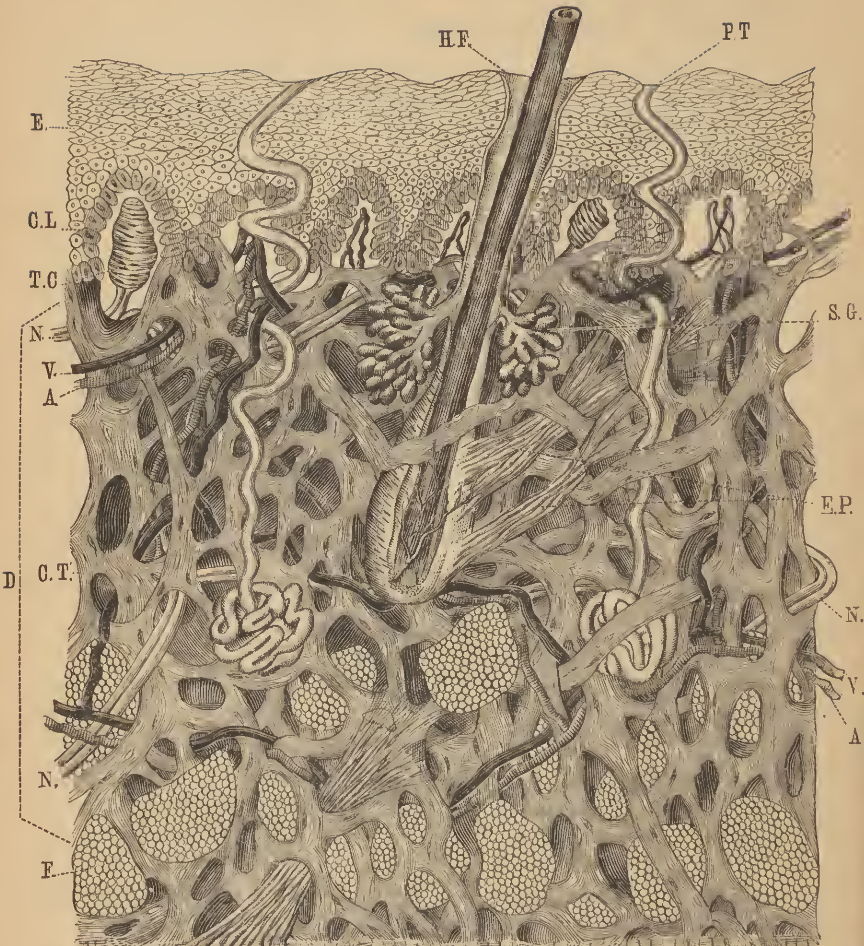

Fig. 25.

Longitudinal section of skin (partly diagrammatic), magnified about 400 diameters. Its structure and contents (with the exception of the lymphatics). — E, epidermis; D, dermis; CL, color layer; TC, tactile corpuscle; N, nerve; V, vein; A, artery; CT, connective tissue; F, adipose tissue; HF, hair follicle; PT, perspiratory tube and gland; SG, sebaceous gland; EP, erector pilae muscle.

CHAPTER V.

THE SKIN.

59. The *skin*, or external covering of the body, a much more important texture than persons ordinarily believe it to be, has been likened to a sentinel, whose duty is to guard the body from attacks both from within and without. It is strong and elastic; varies in smoothness and delicacy in different parts of the body, and has no less than six functions.[1] It consists of *two distinct layers*, the dermis and the epidermis.[2] The former is called also the *cutis vera* or true skin, and the latter the *cuticle*, the false skin, or the scarf skin.

60. The *dermis*, or deeper layer, is composed of a dense network of fibrous and elastic tissue,[3] in the meshes of which are muscular fibres,[4] blood and lymphatic vessels, nerves, sebaceous and sweat glands, hair and hair follicles.[5] The surface of the dermis is raised into prolongations or eminences called *papillae*, which, for the most part, are arranged in groups or rows, producing the ridges and furrows noticeable upon the skin.[6] They are most numerous in its most

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1 See § 73.

2 By some, the connective tissue between the muscles and dermis is spoken of as a *third* layer, though too closely blended with the tissues above it to be readily separated from them. Others again make more than three layers by a splitting up of the epidermis. In this way we have what are called the *Malpighian* and *corneal* layers, etc.

3 For description of these tissues, see Introduction.

4 Muscular fibres are abundant in the skins of many animals, enabling them to shake off insects by a wrinkling motion of the hides.

5 "Little bags" or pouches.

6 These ridges and furrows may be readily distinguished by means of a good magnifying glass.

sensitive parts, such as the palms of the hands, where they number about 35,000 to the square inch. The papillae are made up in part of connective tissue, and of terminal blood-vessels arranged in loops, and of nerves in oval enlargements known as "tactile corpuscles," or "little bodies with touch-power"; for in them the sense of touch resides.[1] The extreme sensitiveness of the papillary portion of the skin is made apparent whenever the raised cuticle covering a blister is broken, and anything, even air, comes in direct contact with the "true skin."

61. Underlying the dermis, and closely blended with it, is the *sub-cutaneous* or *connective tissue*, which contains blood-vessels, lymphatics, nerves, muscular fibres, and adipose tissue. When the normal amount of fat is diminished, the skin becomes roughened and wrinkled.[2]

62. The superficial layer of the skin, *the epidermis*, is composed entirely of cells, and is devoid of blood-vessels and nerves, but through it pass hairs and the ducts of the perspiratory or sweat glands, and of the sebaceous, or oil glands, and from it and the dermis beneath the nails grow. The cells upon the surface of the epidermis, being exposed to the influence of the atmosphere and external sources of injury, become flattened, hard, and horn-like in texture, while the newly-formed under-cells, or those in contact with the papillae, are rounded and soft.

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[1] In the outer portion of the dermis, and below the papillae, other nerves end in enlargements, but are there known as Paccinian corpuscles. The nerves of the skin are sometimes classified as follows: (1) Nerves of *Sensation;* (2) *Trophic* nerves, or those which control the nourishment of the skin; (3) *Secretory* nerves, or those that control the action of the glands; and (4) *Vasa Motor* nerves, or the nerves which regulate the action of the blood-vessels.

[2] "Wrinkled old age" owes its appearance partly also to an increase in the amount of elastic tissue natural to that period of life.

63. Owing to attrition and chemical action, the outer cells of the epidermis *are almost constantly being removed*, while the deeper ones, formed from the dermis, are being pushed forward to take their place, growing harder and flatter as they approach the surface.[1] Having no nerves, the epidermis is not sensitive; and, being without blood-vessels, cannot bleed. It is well adapted, therefore, as a *covering* and *protection* to the sensitive tissues beneath; and this adaptation is nicely adjusted to the demand for it by a proportionate thickening of the epidermis according as the several parts of the body are more or less used. (*a*.)

64. The under-cells contain the *coloring matter* of the skin; and, by the pigment so contained, and its diversified arrangement, are caused the distinctive variations in color of individuals, families, and races. The whiteness of the skin of Albinoes is due to the absence of this pigment, while "freckles," and the peculiar irregular discoloration seen upon the skin of so-called "leopard boys," are owing to variations in its quantity, quality, or distribution. The color of the skin is due in part also to the blood circulating through it; thus, an unusual quantity of red blood in thin portions of the skin causes it to "blush" or redden, while blood tinged by the yellow coloring matter of the bile imparts a "jaundiced" or yellow color.

65. Classified as *appendages of the skin* are the sweat and sebaceous glands (with their ducts), and the hair and nails. In the dermis and subcutaneous tissue are the sweat glands, consisting of numerous coils of exceedingly minute tubing[2] of varying length in the different parts of the body, and surrounded on all sides by a fine network

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[1] A microscopic examination of water in which the hands are washed will almost always show an abundance of epidermal cells, even though the water itself seems quite clear.

[2] About $\frac{1}{370}$ of an inch in diameter.

of blood-vessels; the lower extremity of each coil being closed and turned towards its centre. From the blood in these blood-vessels the perspiration is being constantly filtered out by the tubular sweat glands. By means of the close coiling of the lower portion of each tube, a considerable extent of gland surface is spread out among the terminal blood-vessels. The upper extremity of each glandular coil is the commencement of a perspiratory tube. These tubes extend upwards in nearly a straight direction through the true skin, but in the epidermis present a number of spiral turns. They are mere excretory ducts, and open upon the surface of the body. Their openings, together with the outer openings of the tubes of the sebaceous or oil glands, constitute the "pores."

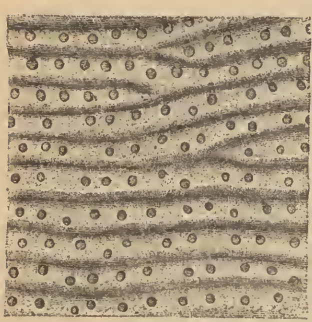

Fig. 26.
Epidermis from the palm of the hand (with its pores), as viewed from the under surface. Magnified eight diameters.

66. Sweat glands are found nearly everywhere in the skin, but are most numerous in the palms, soles, and arm-pits, where they number from 2685 to 2736 to the square inch. Upon the entire surface of the body there have been estimated to be between *two and three millions*, and the entire length of the secreting tubes is said to be about two and a half miles. The very great number of glands, and the coiled and twisted arrangement by which considerable length is attained in minute spaces, indicate the great importance of the work which they have to perform. (*a.*)

67. The *function of the perspiratory glands* is to eliminate the *debris* of used-up tissues, and by a well-balanced

exudation of watery fluid, to keep the body comfortable in the varying temperature and conditions to which it is exposed. Most of the perspiration which is brought to the surface by the sweat glands is immediately evaporated in the form of an imperceptible vapor, and is therefore termed *insensible perspiration*, as contradistinguished from that *sensible perspiration* or *sweat*, which is the result of vigorous exercise, over-heat, etc.

68. Under ordinary circumstances the *amount of perspiration* excreted in twenty-four hours is from two to three pounds, but varies with the temperature, current, and moisture of the air, the depressed or excited state of the nervous system, physical exercise, etc., etc. Workmen in gas-houses, furnaces, iron-works, and other places where they are subjected to great heat, may perspire as much as three pints in an hour. To prevent exhaustion, such persons drink freely of water, or, better still, of water containing oatmeal. A hot and dry atmosphere accelerates perspiration, while a moist or muggy one retards it; and, if warm, produces inconvenience and sometimes great suffering. It is related of Chabert, "the fire-king," that, if the air were dry, he could enter, without discomfort, a chamber where the temperature was 400° F., but could not endure a moist atmosphere of a much lower temperature. Perspiration is also impeded by cold and draughts of air. The importance of a free flow of the perspiration is illustrated by the bad effects resulting from any sudden check of it, as in "the catching of cold," in fever, etc. In such cases extra excretory work is thrown upon other organs, especially upon the lungs and kidneys, by which the health may become permanently impaired.

69. The *sebaceous glands* secrete an oily matter which lubricates the skin and hair, and thus preserves their soft-

ness and pliancy.[1] They are located in the dermis, and are either simple follicles or clusters of simple follicles, called "compound follicles," with tubes connecting the several simple follicles of each cluster with a common or main tube. For the most part the central tubes open into the hair sacs (Fig. 25); while simple follicles, not connected with others, open directly upon the surface of the skin, and are especially numerous about the face. In some of the follicles, however, there are fine downy hairs.

70. *Hairs* are distributed more or less abundantly over the surface of the body.[2] Their bulbs or root enlargements are inserted either in special hair sacs or follicles, or, in the case of the fine downy hairs, in sebaceous follicles. The shafts of the former pass out obliquely through the ducts of the follicles (Fig. 25). Each hair is oval or somewhat flattened, and is composed of a pith-like substance in the centre, surrounded by a fibrous tissue, and this by a so-called cuticle or layer of epidermal-like cells.[3] Hairs are well supplied with blood at the base of the hair follicles, and are living tissues, strong and elastic.[4]

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[1] In sebaceous glands minute (microscopic) animalculae are sometimes found, but are not as frequent or as harmful as some sensational publications would lead us to believe. What are often called "flesh worms" are nothing more than masses of fatty matter tipped by "black points" or dirt, which has adhered to them at the mouths of the sebaceous glands.

[2] It has been estimated that a thin head of hair contains 90,000 hairs, while a thick head of hair has 133,920.

[3] Under the microscope the sides of a hair seem to be roughened. The hair (fur) of certain animals is perceptibly rough to the touch. Human hair may become rough from disease. Very flat hair is apt to curl like a shaving.

[4] It has been found that a hair ten inches long will stretch to thirteen inches; and that a hair stretched one-fifth returned to within one-seventeenth of its original length; also, that a single hair of a boy, 8 years of age, supported a weight of 7,812 grains; one of a man of 22 years, 14,285 grains; of 57 years, 22,222 grains.

71. *The hair has various uses.* That upon the head and face protects from cold and excessive heat. The eyebrows prevent the perspiration from running into the eyes, the eyelashes keep out dust, while the hairs at the orifices of the nose and ears protect those parts from dust, insects, etc. To the hair follicles, muscular fibres (*erector-pilae;* Fig. 25) are attached, which, under the stimulus of fear, horror, cold, etc., cause the follicles to be more perpendicular, and thus the hair to "stand on end." Hair is subject to various diseases which may shorten its length, change its color, or destroy it. It is affected by the same conditions as the skin, of which it is a part. (*a.*)

72. The *nails* are modifications of the epidermis, identical in formation, but peculiar in appearance and manner of growth. The nail rests in a "matrix," which is a fold of the dermis, particularly rich in papillae, from which the nail cells are produced. When nails are destroyed, new ones will be formed if the matrix is uninjured. Nails are a support and a defence to the ends of the fingers and toes, and assist in the picking up of small objects, and, if healthy and in good condition, add comeliness to the parts to which they are attached. The health of the nails is affected by local or general diseases. They may become rough or split or marked by grooves or discolorations, as the result of disease.

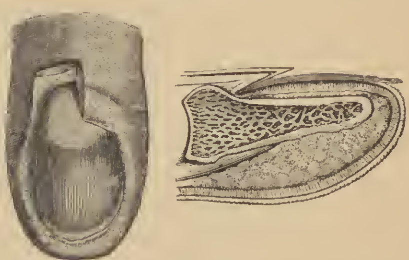

Fig. 27.

Two views of the end of a finger. In the first, part of the skin covering the base of the nail is cut and turned back to show the base of the nail. In the second (a perpendicular section), the relations of the nail to the skin, fat, muscle, and bone are shown.

73. The *functions of the skin* are six in number,—it is a covering and protector of the external surface of the body; an organ of sensation; an organ of excretion; a regulator of temperature; an organ of absorption; and an accessory organ of breathing.

74. *First.* It is a *protective covering.* In a good sized man it contains about seventeen square feet of surface, is thick and strong upon those parts most subject to pressure and friction, but thinner where motion or greater elasticity is necessary, as on the eyelids, in the armpits, under the knees, and over the abdominal organs. When covered with hair, it becomes an especially strong protector to the parts beneath.

75. *Second.* Being abundantly supplied with nerves, the skin is also an *organ of sensation*, enabling us to appreciate all degrees and varieties of touch and temperature. The value of this sensitiveness is especially appreciated in the different trades and avocations of life, and most of all when it is diminished or lost. In a palsied limb it may happen that a severe frost-bite, burn, or other injury will even destroy the tissues without the knowledge of the sufferer. The sensibility of the skin is greatest on the pulps of the fingers and the front of the body, and least in the middle of the limbs and on the back.

76. *Third.* The skin serves also as an *organ of excretion*, purifying and eliminating from the blood the waste products in solution in the perspiration. These *excreta*, in addition to the water, are carbonic acid, fatty acids, ammonia salts, etc. In disease there is an effort to eliminate also various other abnormal and injurious products.

77. *Fourth.* The skin is the great *regulator of animal temperature.* "Animal heat" is produced by the various

processes carried on in the body. Though the general temperature of the human body is about 98½° F., there is a normal variation within the limits of health of about 1° below and above that point. Loss of heat is produced by contact of the body with anything cold, by radiation, and through the excretions; but the due regulation of the bodily temperature depends, in part, upon the elimination of watery vapor by the lungs, but mainly upon the perspiratory function of the skin. The constant evaporation of the perspiration into the surrounding air is the most powerful of all the means whereby the surplus heat is carried off and the body kept at its normal temperature. In health, whenever the body begins to suffer from excess of heat, as, for example, after violent exercise, the skin forthwith responds to the urgency of the occasion, and, pouring out its due amount of insensible perspiration, or of sensible sweat, an adjustment of the temperature is effected, and the proper standard preserved.[1]

78. *Fifth.* The skin is *an organ of absorption.* It takes up and passes through it into the lymph and blood-vessels certain substances with which it may come in contact. It has been found by experiment that the body absorbs water through the skin. (*a.*) Certain drugs, as strychnine, quinine, mercury, and belladonna produce their usual effects when applied to the tender parts of the skin. The rubbing in of oily preparations, *i.e.*, inunction, has long been used to increase warmth and furnish nourishment. Careless workmen in lead works, painters, and mirror-silverers are often poisoned by lead or mercury absorbed through the

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[1] The value of the skin as a regulator of temperature is sometimes strikingly shown when, from "catching cold," the body is alternately chilly or hot. A proper bath taken early in this disordered condition produces a "sweat," and the equable normal temperature is regained.

skin. The evil effects which have been stated to result from cosmetics and hair dyes are due, of course, to the absorption of harmful material. Friction increases the rapidity of absorption.

79. *Sixth.* Lastly, the skin, by virtue of its powers of absorption and excretion, serves as an accessory organ of breathing. It absorbs a small amount of oxygen, and gives out a larger amount of carbonic acid, performing, it is estimated, from one-fortieth to one-fiftieth of the respiratory function.

80. Owing to the extent, structure, and variety of functions of the skin, its *condition has much to do with the general health.* The skin, lungs, liver, bowels, and kidneys are allies in physiological action. All excrete waste material, each in its own way. If, therefore, from any cause, the normal action of any one or more of these organs is interfered with, extra and unnatural work is thrown upon the others, and the excessive excretions produce discomfort, and often inflammatory disease of greater or less danger.[1] The skin is also *intimately connected with the internal organs* by nerves and vessels. Hence, if it be severely injured, as by an extensive burn, these organs may become inflamed and death result. Conversely, because of the same intimate connection, or "sympathy," as it is sometimes called, indigestion often causes eruptions to appear upon the skin.

[1] At the coronation of Pope Leo the Tenth, a little boy, representing an angel, whose skin was gilded, died as the result of stoppage of the "pores." In like manner, animals, varnished all over, have died.

QUESTIONS.

1. Describe the skin and name its different layers.
2. Locate and describe the dermis.
3. What are the papillae, and what peculiar power resides in them?
4. Where is the subcutaneous tissue, and what does it contain?
5. Where is the epidermis, of what composed, and what passes through it?
6. To what is the color of the skin owing?
7. Of what use is the epidermis, and how is it adapted to its use?
8. What are the appendages of the skin?
9. Describe the sweat glands and their functions?
10. What affects the flow of perspiration, and, if checked, what follows?
11. Describe the sebaceous glands and their uses.
12. Describe the hair and its uses; the nails and their uses.
13. What are the functions of the skin? Describe each.
14. Explain why the skin and other excretory organs are mutually affected by the condition of each other?
15. What connection has the condition of the skin with the general health?

CHAPTER VI.

BATHING.

81. Bathing has at all times been considered of value, though its full importance as a *sanitary measure* is not even yet generally appreciated. The bathing establishments of the Ancients were many and magnificent, and were patronized by multitudes daily, partly for health, but largely because bathing in them was inexpensive, and the baths were luxuriously appointed. In Eastern countries, bathing has always been a religious rite. From time to time it has been regarded as a diversion by the devotees of fashion. But the large amount of waste material thrown off by the skin, and the continual lodgement upon it of foreign matter, should make bathing both a religious duty and a perpetual fashion.

82. It *assists the skin in the discharge of its functions*, and *removes dirt*, *odors*, *and poisonous materials*. Perspiration, ordinarily a harmless fluid, if allowed to accumulate upon the skin, mingled with dirt of various kinds, clogs the pores, and may even undergo chemical changes, and become an irritant, or produce poisonous matter which may be absorbed into the system.

According to the eminent English sanitarian, Mr. Chadwick, "*Skin cleanliness augments the nutritive effects of food.*"[1]

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[1] He adds: "It should therefore be preached to the poor, as an additional inducement to skin cleanliness, that the same food which is required to make four children that are kept dirty thrive, will serve to make five thrive whose skins are daily washed and kept clean."

In other words, the assimilation of new materials is promoted by a more thorough getting rid of the old.

Again, bathing keeps the pores open, promotes excretion, and thus renders valuable aid in regulating bodily temperature, and in warding off colds,[1] fevers, skin eruptions,[2] and internal disorders. On the other hand, various skin and contagious diseases owe their origin to, and spread most rapidly among the slovenly in the crowded portions of cities.

83. The *kind of bathing* to be selected, and *how* and *when* to bathe, depend upon the age and health, the peculiarities and occupation of the individual, the state of the weather, etc. The ordinary water baths are classified as to temperature as hot, warm, tepid, temperate, cool, and cold.[3] The daily use of temperate and tepid baths agrees with most persons, but it is desirable to become accustomed to cool water if we wish the tonic effects of bathing. This can often be accomplished by gradually lowering the temperature of the bath a little each time, or by following up a sponging with tepid water by one with cool water. It should, however, be quickly performed, and in a warm room, and be accompanied by a brisk rubbing of the skin

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[1] It is believed, by many medical authorities, that proper and systematic bathing will, to a great extent, prevent or cure "catarrhs" or colds in the head, throat, or lungs. Dr. C. R. Agnew, after twenty-nine years' practice in New York City, writes: "Inattention to health laws produces defects in tissue building. There is a morbid sensibility of the skin and mucous membranes. I arrive at the causes by the result of treatment, for I find, that by proper shoeing, open fires, the cold bath in the morning on rising, followed by brisk rubbing with a pair of English bath-mittens and the use of the strap, and by the exposure of the skin to the air, very many times catarrhs disappear without any local treatment whatever."

[2] It is the testimony of many fat persons, that systematic bathing prevents and cures chafing of the skin much better than powders, ointments, etc.

[3] Hot, 98° to 112° F. Warm, 92° to 98° F. Tepid, 85° to 92° F. Temperate, 75° to 85° F. Cool, 60° to 75° F. Cold, 30° to 60° F.

with the hands, a towel, mittens of crash towelling, or a flesh-brush.[1] In the case of old and feeble persons, whose circulation is sluggish, tepid water alone should be used, and friction may be applied over a loose flannel gown put on the dampened body. Comfort may sometimes be derived from friction, especially of the upper part of the body, with mittens merely dampened, or by dry rubbing with mittens or with the hands.

84. For *very young children*, a sponge or dip bath of tepid water is desirable, given each day or alternate day. But the child should gradually become accustomed to cool water; and after all baths, its skin should be thoroughly but gently rubbed, dried, and warmed, for little children lose heat rapidly, and imperfect drying increases the liability to catch cold. *Older children* in health, who exercise in the open air, may bathe to advantage daily in even very cool water, if the bath be a short one, and followed by brisk friction. Many adults are benefited by such daily bathing, and persons who work in a dusty atmosphere may need even more than one bath per day. If, from any cause, the entire body cannot be bathed, the bathing of the head, neck, chest, and feet will generally afford comfort and strength.

85. *Hot* and *cold baths* are to be used with caution, and especially by persons with heart disease, or far advanced in consumption, or when greatly fatigued. Hot-water baths are more cleansing than cold water, but are generally more relaxing, and have not the tonic properties of the latter.

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[1] Such bathing, lasting only from five to eight minutes, is valuable in the morning, on rising, for the majority of people. Sometimes a few drops of ammonia-water, or some salt added to the water of a bath, renders it more stimulating. Children and feeble persons have repeatedly become accustomed to cool and even cold baths by gradual training as above.

Once a week is often enough to use a hot-water bath. Frequently resorted to, danger may result from over-stimulation and subsequent depression of the heart and nervous system. Individuals in robust health may enjoy frequent bathing in cold water, even in cool rooms, if the bathing occupies but a short time, and is followed by brisk friction, but the practice is attended with risk.[1]

86. The *value* of a bath is determined by its *ultimate effects*, and is influenced largely by the time of day in which it is taken. The *immediate effect* of very cool or cold water applied to the skin is to chill the surface of the body (the "first shiver"), lowering its temperature, producing pallor by driving the blood inwards, and through contraction of the skin muscles, especially those attached to the hair follicles, giving rise to the appearance called "goose skin." If bathing be now unduly prolonged, the *secondary effects* (the "second shiver") appear, *i.e.* marked chilliness, lassitude, and in some instances great prostration.

87. The *first effect* of a *warm bath* is to quicken the pulse and respiration, and raise the temperature of the blood, and bring it to the surface, making the skin glow. Following this effect are chilly sensations, and an appearance of "goose skin," and, unless the bather finishes his bath, or moves about actively, he is liable to catch cold, especially if bathing in a cool room. Hot water applied to the skin promptly stimulates it, and is as promptly followed by chilliness, lassitude, and prostration if the bather is not robust and active, or the bath-room is cool.

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[1] There are people, undoubtedly, who can break the ice in ponds, and plunge in with impunity, but the majority of persons cannot. Sometimes bathing must be so nicely adapted to the individual's needs, that only a physician can decide what kind it must be, and how and when it is to be resorted to

88. After all kinds of bathing there should be *reaction* or the attempt on the part of nature to raise or lower the temperature, as the case may require, to the normal point. If the "reaction" is well marked, the bather feels generally better, the skin glows, the mind is clearer, appetite is increased, etc. If, on the contrary, the result of a bath is depression, chilliness, paleness of the skin, etc., the bathing has been improper, and may induce disease of the internal organs.

Proper bathing should tone up the system by increasing the force of the respiration and circulation, and by strengthening the nerve power. Just as some require vigorous, and others gentle exercise, some a cold and others a warm climate, so for some the cold, and for others the warm bath is most desirable.

89. As to the *times for bathing*, — though very strong and healthy persons may, with impunity, bathe at almost any time, and in water of any bearable temperature, — yet, for the majority, it is not prudent to bathe in hot or cold water before breakfast, as at that time the bodily powers are weakest; or to take a prolonged bath in water of even moderate temperature when fatigued, or just before, or just after a hearty meal or unusual exercise. About 11 A.M. is a suitable time for most persons. Feeble people, however, who catch cold easily, can generally bathe more safely just before going to bed. After bathing, they need extra warm bed-clothing, but should not have enough to produce sweating.[1]

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[1] At the seaside, only the hardiest should attempt an early "morning dip in the surf." Many persons are there injured by bathing very soon after a hearty meal of clams, fish, etc. Such food needs strong digestive powers and ample time for digestion. This process is interfered with by such bathing, and blood is diverted in increased quantity into weak blood-vessels, causing sometimes apoplexy and death.

90. In addition to the ordinary fresh-water baths, there are salt or sea-water baths, mineral baths, and other baths resorted to for cleanliness, or as means of nourishment or for their supposed medicinal effects. Such are the Russian or vapor bath,[1] the Turkish or hot-air [2] bath, and the cold-air, sun, broth, and even mud and blood baths.

91. *Salt-water bathing* has greater tonic effects than fresh water. At the sea-shore the air also contains particles of salt. There, too, are new scenes and surroundings, and the water dashing with force against the body, gives occasion to vigorous, muscular exercise and social hilarity. All this exercise, combined with the stimulating properties of the salt water itself, tends greatly to quicken the circulation, and to add value to the bath. But to obtain all the good effects, the bather should first thoroughly wet the head and shoulders, then dash into the water, move briskly about, and come out before feeling tired or chilly. He should then rub dry and dress quickly.[3]

92. *Mineral baths* are baths of water containing various natural or artificial mineral salts. Certain mineral springs —those of Arkansas and West Virginia for example — are much resorted to by invalids.

93. The *Turkish bath* is a valuable method of cleansing the body and "equalizing the circulation," and is generally preferred to the *Russian bath*, where the air is hot and moist. But after the bath, the bather should remain in the waiting-

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[1] 100° to 130° F. [2] 110° to 200° F.

[3] Salt water being more dense than fresh, is much easier to float and swim in, and is for this reason preferred by bathers. The weight of the human body in life, with the lungs healthy and inflated, is generally less than the same bulk of water, hence, it need not sink in either fresh or salt water. Sometimes persons do sink because they become alarmed, and, in their fright, fail to inflate the lungs, but raise the arms, thereby submerging the mouth and nostrils.

room for a considerable time before venturing into the outer air, and should then be well wrapped up, and should not expose himself to draughts by standing on street corners, riding in open vehicles, etc., but may, to advantage, take a moderate walk.[1]

94. The Ancients esteemed *sun baths* for their remedial effects, and had places assigned in their gardens and buildings where the body could be exposed to the sun's rays. (*a.*) At the present time, much value, in certain quarters, is attached to the sun bath.[2] In some parts of Germany, *mud baths* are used for their supposed medicinal effects. So milk, blood, broth, oil, etc., are in some places applied to the skin as nourishing agents. Inunction with oil or vaseline after a bath is known as a "Roman bath," and is sometimes of value in softening harsh skins and increasing warmth.[3]

95. *Soap* is almost always necessary as an adjunct of bathing to remove, by its chemical action, greasy particles, but the oftener we bathe the less will soap be needed. Soap should be of the very best quality. Poor soaps, containing an excess of alkali, made from poor fats or oils, or containing impurities,—such as have been found by investigation with the microscope, viz., small pieces of bone, decaying

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[1] It is astonishing how different one feels after a Turkish bath properly given. Mapother states, that in the East, where the baths are very thorough, and are accompanied by much shampooing and friction, the "skin of only one week's date when collected is often as large as one's fist." Sidney Smith, in a letter from a hot bath in Germany, says: "They have already scraped enough off me to make a curate."

[2] Some institutions, as the New York Hospital and the Hospital for Crippled Children, have their *Solaria* or sun-rooms, in which certain feeble persons are placed each day.

[3] The South-Sea Islanders are said to anoint the body freely with the oil of the cocoanut before and after bathing in the sea. It is said to increase their powers of endurance in the water.

connective tissue, and even pus cells, — will irritate the skin and produce eruptions.[1] Soaps made of good animal fat and potash, or borax, good "castile" soap for example, or those made of vegetable fats, as tar, almond, palm, etc., are the best.

QUESTIONS.

1. Why is bathing important to health?
2. Upon what do the times, manner, and hours of bathing depend?
3. What is the proper bathing for different ages?
4. What effects follow proper and what improper bathing?
5. What as to cold and warm water respectively?
6. What are the best times for bathing?
7. How are water baths classified, and what can you say of the several kinds?
8. What other baths are there, and what can you say of them?
9. What can you say about soap?

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[1] Among the very poor, common laundry soaps are frequently used for toilet purposes. Some of these soaps are injurious. The demand for "cheap articles" has brought into the market many toilet soaps, too cheap sometimes to be reliable.

CHAPTER VII.

CLOTHING.

96. When the body is exposed to a temperature lower than its own, heat is abstracted from it by radiation, by evaporation of surface moisture, and by conduction or direct contact with the air. The great *object of clothing* is to prevent this loss. Clothing not only hinders too rapid evaporation from the body, but being, together with the warmed air confined between it and the body, non-conducting, a loss of heat from direct contact with the outer air and other cold objects is avoided, and radiation is materially checked. We are thus enabled to bear more easily sudden changes of temperature, especially those of us who are delicate and sensitive.[1]

97. The retention of animal heat, besides being essential to comfort, is valuable also as an economizer of the natural forces. An exhausting expenditure of nervous and muscular energy to create animal heat is thereby avoided, and the food, instead of being used up as fuel in supplying a constant waste, is saved for the construction and repair of tissue. The bearing of this upon the more legitimate demands for nervous and muscular force must not be overlooked. It is well known that both human

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[1] "The best way then to avoid catching cold, although it may seem a paradox, is not to be too much afraid of cold. Let one's accustomed exercise not be interrupted because it is damp, or even rains. Let these conditions be met by appropriate clothing, and let the feet be well protected by strong shoes."—*Physiology for Practical Use.* HINTON.

beings and animals, when warm, require less food and can do better work than when chilly or cold.[1]

98. The non-conducting properties of clothing, and of the confined air under it, render it also a protection to the body from external heat. *Other objects of clothing* are to protect the skin from dust and external sources of injury, and particularly from the injurious influences of the winds, damp air, rain, hail, and snow, and from contact with poisonous substances. Of clothing as a covering and an ornament of the body mention also may be made.

99. What constitutes *proper and improper clothing* is a matter for careful consideration. Nature provides the inferior animals with a natural covering that is beautiful, complete, and admirably adapted for varying seasons and climates; but God-like man, in this as in other respects, is left with a power of choice that has for its consequences life or death, a blessing or a curse.

We have already seen that *freedom of movement* is indispensable in the various forms of muscular exercise, and in the performance of vital processes. It follows, therefore, that any clothing which interferes with this freedom is strictly to be avoided.

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[1] "Our clothing is merely an equivalent for a certain amount of food; the more warmly we are clad the less urgent becomes the appetite for food, because the loss of heat by cooling and consequently the amount of heat to be supplied by food is diminished." — LIEBIG.

"Warm clothes are as desirable in winter as are sufficient supplies of food, and to a great extent these are interchangeable; the well-fed person withstands cold well, and needs but light clothing compared to the ill-fed person, who must be warmly clad. . . . The hybernating animals, as the hedge-hog, the mole, and the viper or the frog, could not maintain themselves alive on the material stored up in the body, if they did not also locate themselves so that their heat is not readily radiated away." — *The Maintenance of Health.* FOTHERGILL.

100. *Heavy or tightly-fitting head coverings* overheat the scalp and exclude the air. Their pressure obstructs the blood supply and the free action of the nerves, inducing headache and baldness. *Tight cravats*, *collars*, and *bands* press upon the windpipe and the important blood-vessels, nerves, and other structures of the neck, thereby impeding the passage of air, blood, and nerve currents, and producing discomfort, a sense of fullness in the head, headache, disturbance of vision, etc. Says a writer: "Some years ago many British soldiers fell victims to close military stocks, which, obstructing the easy return of the blood from the head, produced cerebral congestions and apoplexy."

101. The shoulders should bear a large part of the weight of clothing; but the pressure of arm-hole seams of outer garments and the shoulder bands of under clothing upon the arms below the shoulder joints hinder the free play of those important members, and are obstructions to proper muscular exercise.

102. The normal movements of the lungs, heart, and other organs are disturbed whenever the free movements of the ribs are restrained by tight coats, corsets, vests, or bands. (*a*.) Such compression, more than any other, deranges the vital processes, producing suffering which is often referred to other causes. Among its effects are lassitude, headache, cold feet, shortness of breath on exercising, dyspepsia, faintness, many derangements of the functions of internal organs, and sometimes deformities of the chest, and, in persons of weak lungs, consumption.[1]

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[1] Persons who wear tight clothing about the chest seldom admit the fact any more than they will confess to other sins. A simple experiment, however, will convict the sinner. It is well known to medical examiners of life insurance companies, and for the army and navy, that the measurement around the

103. Sometimes clothing is held in place by very tight belts, which impede the free movements of the abdominal organs, and cause various disorders. Elastic bands in garters and shoe-tops are sometimes so tight as to affect seriously the circulation of the blood in the parts pressed upon.

104. No articles of dress need to be so nicely adjusted, perhaps, for the comfort of the individual as *boots and shoes*.[1] If too large they cause discomfort, loss of temper,

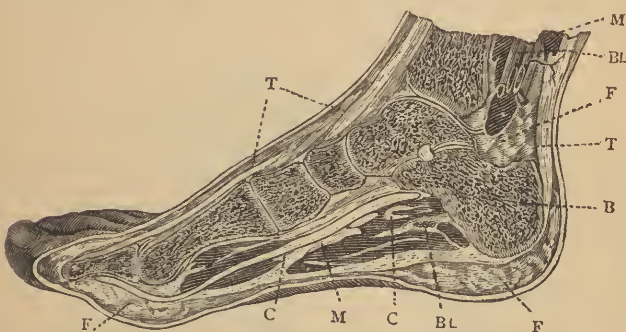

Fig. 28.

Vertical section of right foot, showing the arches and the relations of the various structures. — B, bones; M, muscles; T, tendons; F, fat; C, connective tissue; BL, blood-vessels.

corns, bunions, etc.; if too small they do all this and more. They interfere with muscular exercise, cause cold feet, pain, and deformity. (*a*.) But so imperative and

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middle of the chest, even with the clothes on, should show at least *two inches* difference between the chest expanded by full inspiration and contracted by forced expiration. The difference, in health, is from 2 to 4 inches, the average being about 3. Now, a chest that expands (after being emptied as far as possible of air) only 1¼ to 1¾ inches with tight garments on, will often expand 2½ to 3½ inches with the garments removed. This last degree of expansion is the normal one, and any garment that lessens it is too tight.

[1] "It is said that the Duke of Wellington, being questioned as to the most essential requisite of a soldier's clothing, replied, 'a good pair of shoes.' What next? 'A spare pair of good shoes'; and even thirdly, 'a spare pair of soles.'" —*Lectures on Public Health.* Dr. Mapother.

universally submitted to are the regulations of fashion, that it is only with considerable difficulty, in spite of our boasted enlightenment, that proper shoes and boots can be bought.[1]

105. In shoes modelled upon lasts of wrong shape the weight is thrown upon or toward the outer side of the foot, instead of being borne, as it should be, directly over a line drawn from the middle of the heel to the middle of the big toe. (Fig. 1.) If to such shoes high heels are added, and especially if they are near the middle of the

Fig. 29.
A, normal foot, proper position of toes ; B, normal foot, with an outline of the front part of an improper shoe ; C, toes crowded out of position as result of wearing such an improper shoe.

soles, an unnatural mincing gait, not unattended with danger, is the result. The weight of the body is thrown forward upon the toes, the ligaments of the various joints are strained, especially those of the spinal column, knees, ankles, and toes. The muscles of the back of the leg are

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[1] At the present time proper boots and shoes are made "to order" by some "anatomical boot and shoe makers," but are generally too expensive for ordinary use. Ready-made foot coverings generally follow the fashion, and if found properly constructed are almost sure to be "out of style."

deprived of their important share of work, and overriding and other deformities of the toes are produced. In some instances important tendons which pass around the outer ankles have been thrown out of their grooves, and lameness has resulted.

106. Boots and shoes should fit the feet snugly, especially over the instep, but should allow free movements of the various joints. They should have broad soles, low and broad heels, should not cramp the toes, should be hollowed out but little if at all on the inner

Fig. 30.
An improper shoe.

Fig. 31.
A proper shoe.

side, and should be so shaped that the weight of the body may be borne where nature intended it should be. These simple requisites would give us sensible, comfortable, aye! and good-looking foot coverings.

107. The *quantity of clothing* should be sufficient to keep the body comfortably warm, and should be increased or diminished with the change of the season or of the temperature. It is important, indeed, that the body should become used to the slight changes in temperature

so repeatedly occurring day after day; but the practice of "*hardening*" *by exposure* (as is done, for example, with the limbs of little children) is often attended with danger.[1] Neither is it prudent to throw aside warm clothing before the actual onset of warm weather, or to delay putting it on till cold weather has far advanced.

108. On the other hand, *too much clothing* has also its bad effects. It induces free perspiration, which, retained in contact with the skin, proves an irritant. The skin, from being unaccustomed to the stimulating effects of a tonic atmosphere, becomes susceptible to very ordinary changes in temperature. Hence, persons who are in the habit of wearing thick wrappings about the neck, such as tippets, fur collars, etc., are very liable to throat affections, especially if the clothing should be removed where there is any draught of air.[2]

As far as possible, clothing should cover all parts of the body equally. Hence, padding a part of the clothing, while other portions are made quite thin, is objectionable. So, too, "full dress," in the fashionable sense, is not full enough in a cold room, or on going out of an overheated room in cold weather. Warmth, however, depends more upon the material and structure of the clothing than upon the quantity.

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[1] Proper care of the skin, by systematic bathing and well-regulated clothing, will in reality "harden," while exposure of tender skins is dangerous to health and life.

[2] "A regiment of infantry, according to Baron Percy, being on their march in hot and stormy weather, the soldiers became heated and out of breath. The colonel permitted them to take off their stocks. Soon afterwards they entered a gorge of the Vosges, exposed to the north-west wind, without covering the neck. On the following day 73 soldiers were sent to the hospital, the greater part attacked with inflammatory sore throat, and in a few days more than 300 others were taken sick, apparently from the same exposure." — *Dunglison on Human Health.*

109. *Lightness*, *proper ventilation*, and *warmth* are the three desirable qualities in clothing, and may be combined in a loosely-woven cloth, whose meshes contain confined air. Air is one of the best non-conductors of heat known; but if left free, it abstracts heat also by promoting evaporation from the skin, and by keeping up a continual contact of fresh unwarmed particles. But confined air prevents rapid evaporation as well as radiation and the actual contact of colder bodies. Hence mittens, as containing more confined air, and also because the fingers are in contact, are warmer than gloves. Two pairs of cotton stockings are greatly conducive to comfort, because of the warmed air between them. Two undershirts sometimes give more comfort than an overcoat, and are an especial protection against sudden exposure. Felt shoes are warmer than leather ones. So, woollen stockings drawn over shoes keep the feet in a more comfortable condition when walking through snow than even thick shoes. The "clouds" worn by ladies as head covering are both light and very warm.[1]

110. Clothing that is much worn needs a *texture* that will admit fresh air through it, or should be so arranged

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[1] A few folds of newspaper put between two blankets or other covers, to keep them smooth, will furnish sufficient bed-clothing for a bitter winter's night. In addition to the superior non-conducting quality of paper, its porosity allows of a ready escape of the insensible perspiration without the cooling effects of evaporation. The sleeper is kept, therefore, dry and warm, and never experiences that clammy dampness which results from thicker bed-clothing; nor does he suffer from an oppressing weight. To the rattle of the paper he will soon accustom himself. Paper has also been used to advantage in the shape of undervests, and in the soles of shoes.

As to bed-clothing, so-called "comfortables" are sometimes very uncomfortable, on account of their weight, which impedes the circulation and prevents the escape of the insensible perspiration, and the sleeper awakes in the morning damp and even uncomfortably cold.

that the air may pass beneath it. Tightly-woven and close-fitting underclothing, and impervious rubber outer garments, retain the impurities from the skin in contact with it. Much better are the loosely-woven, net-like undergarments now made, and the gossamer rubber ones, which in some instances are ventilated by valve-like openings under the arms and on the back. While it is prudent to provide ourselves with overcoats, wraps, and rubber garments during a storm, they should be removed, or at least unfastened, when in-doors or not exposed to the fury of the elements.

111. *Wet clothing* chills the skin, cools the air in contact with it, hinders the escape of impurities, and should be removed as soon as possible and the body made dry and warm, and dry clothing substituted. If caught in a storm, when unprovided with wraps, etc., the increased animal heat afforded by walking or other continuous exercise will usually avert evil consequences.

As with day clothing, so that of the *night*, including *bed coverings*, should be light, dry, airy, and warm. There should be a complete change of clothing at night. Much of the wakefulness and feverishness then experienced is undoubtedly due, if not to impure air, to unaired clothing. As Miss Nightingale puts it: "Feverishness is generally supposed to be a symptom of fever, — in nine cases out of ten it is a symptom of bedding."

Unclean clothing, besides keeping the skin in a foul condition, is most liable to become a receptacle for germs of disease. Clothing worn by attendants in cases of scarlet fever, small pox, or other contagious disease, is a constant source of contagion, and should be destroyed by fire as soon as possible. (*a*.)

112. *Color in dress* is nŏt merely a matter of taste, but, in a physiological sense also, is no unimportant consideration. Benjamin Franklin first demonstrated, by means of various colored cloths placed upon the surface of snow, that black, under the sun's rays, was the warmest color, and white the coolest.[1] Dark colors, — black, blue, etc., — are considered best for general use in cold weather; and white, gray, etc., in hot.[2]

Owing to the demand for cheap and bright-colored clothing, those of poor and rough material, colored with cheap and poisonous dyes containing arsenic, copper, etc., are quite often thrown upon the market. Colored socks, tights, under-shirts, chest protectors, linings of hats, boot-tops and gloves, have often, in consequence, been found

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[1] Of cloth of different material exposed to the suns rays —

"White Cotton received	100° F. of heat.
" Linen received	98° F. of heat.
" Flannel received	102° F. of heat.
" Silk received	108° F. of heat."

Of shirtings of different colors so exposed —

"White received	100° F.
Pale straw color received	102° F.
Dark yellow received	140° F.
Light green received	155° F.
Dark green received	168° F.
Turkish red received	165° F.
Light blue received	198° F.
Black received	208° F."

— *Dict. of Hygiene and Public Health.* By A. WYNTER BLYTH and PROF. TARDIEU.

[2] "Clothing has frequently been the agent through which infectious disease has been propagated. Judging from Stark's observations on the power of absorbing odors, the probability is that contagion is absorbed after the same manner. Stark found that the absorption of odors was in proportion to the hygroscopic absorption, and that it depended in a great measure upon color, — black absorbing most, then blue, red, green, yellow, and lastly white. For a nurse a dark woollen garment is the worst, and light-colored cotton best." — *Dict. of Hygiene and Public Health.* London.

to be poisonous. The dyes act with especial force in hot weather, when by perspiration they are dissolved out.[1]

113. In our variable climate *woollen* under-garments of varying thicknesses for the different seasons should be worn. Intermediate garments, such as waists and vests, may be more closely woven, and made with especial reference to wear, while the outer garments can be arranged with greater regard to the mere appearance. Woollen or silk cloth is a better retainer of heat than cotton or linen. The open texture of woollen cloth is filled with confined air, and its ability to retain moisture, whether from the skin or from outside, prevents the cooling effects of a rapid evaporation. Hence flannel and merino, in our changeable climate, make excellent under, intermediate, or outer garments.[2]

114. *Silk* is the next most suitable material, especially for under-garments; then *cotton;* and lastly *linen.* Linen

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[1] So frequent have such cases of poisoning become that in some States special laws have been enacted in behalf of the sufferer against the manufacturer.

"The symptoms produced vary somewhat; usually they consist in redness and staining of the part, followed by swelling, itching, and smarting, with the formation of little blisters or vesicles, which break and give exit to a discharge. The part affected then becomes decidedly painful, and is occasionally greatly swollen. There is also a great deal of constitutional disturbance, and in fact the sufferer is quite ill. The peculiar staining of the skin, coinciding with the particular hue and pattern (bars, stripes, etc.) of the colored article, at once suggests the cause of the mischief." — *The Skin and its Troubles. Health Primer.* London.

[2] The favorite receipt of the celebrated English physician, John Hunter, for the rearing of children, was "plenty of milk, plenty of sleep, and plenty of flannel." It is stated by physicians in hot countries that the wearing of wide flannel bandages (doubled) over the abdomen is a capital safeguard against cholera and bowel affections, and against a sudden check of the perspiration. Street laborers, soldiers, factorymen, etc., find by experience that they can wear flannel with comfort when exposed to varying changes in the atmosphere and at hard work. It is said that in rainy weather sailors wring out the water from their woollen jackets and put them on again, seldom catching cold.

being a good conductor, and thin and closely woven, is too cool for winter use, or for an under garment when the wearer is working hard, or is exposed to a changeable climate, or in factories where there is great heat, and the opening of doors, windows, flues, etc., causes draughts of air. For those whose skins are irritated by flannel, linen, cotton, or silk garments may be worn next the skin, with flannel over them.[1]

QUESTIONS.

1. Why does clothing keep us comfortable, and what other use has it?
2. What are the evil effects of tight clothing? Illustrate.
3. What of too tight or too heavy clothing, respectively?
4. What are the three desirable qualities in clothing, and how are they best combined?
5. How and why may air be made useful in our clothing? Illustrate.
6. Why should clothing have ventilation?
7. What are the bad effects of wet clothing?
8. Of what sort should our bed covering be?
9. What may result from unclean clothing?
10. Of what importance is the color of clothing?
11. What bad effects have improper dyes?
12. What is to be said of the different materials in clothing?

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[1] For a close head covering (nightcaps, for instance), silk, because of its superior non-conducting property, is, to such as require a cool head, the very worst.

ANALYSIS OF THE FIFTH, SIXTH, AND SEVENTH CHAPTERS.

THE SKIN.

I. Anatomy.

- 1. Structure
  - Epidermis, — Cells.
  - Dermis
    - Connective tissue
    - Fat
    - Blood-vessels
    - Nerves
    - Lymphatics
    - (Connective tissue, Fat, Blood-vessels, Nerves, Lymphatics:) Color derived from pigment and blood.
  - Sub-cutaneous connective tissue.
- 2. Appendages
  - Hair.
  - Glands, — sebaceous and sweat.
  - Nails.

II. Physiology.

- 1. Functions
  - A protective covering.
  - An organ of sensation.
  - An organ of excretion.
  - A regulator of temperature.
  - An organ of absorption.
  - An accessory organ of breathing.

III. Hygiene.

- 1. Bathing
  - Uses
    - To assist the skin in discharging its functions.
    - To promote health and fortify against disease.
  - Proper and improper bathing.
  - Effects of.
  - Times for.
  - *Baths*
    - *a.* As to *temperature*
      - Hot.
      - Warm.
      - Tepid.
      - Temperate.
      - Cool.
      - Cold.
    - *b.* As to *water*
      - Fresh.
      - Salt.
      - Mineral.
    - *c.* Vapor or Russian.
    - *d.* Air, — [Hot or Turkish. Cold].
    - *e.* Sun. Mud. Broth. Blood, etc.
  - Adjuncts
    - Friction.
    - Soap.
    - Inunction.

HYGIENE. — *Continued.*

- 2. Clothing . . .
  - Uses . . . .
    - To prevent loss of heat by . . . . .
      - Radiation.
      - Conduction.
      - Contact.
    - To protect externally from heat and other sources of injury.
    - As a covering.
    - As an ornament.
  - Proper and improper
    - Fit.
    - Quantity.
    - Condition
      - Dry and damp.
      - Ventilation.
      - Cleanliness.
      - As to contagion.
  - Color and dyes.
  - Material . .
    - Linen.
    - Cotton.
    - Wool.
    - Silk, etc.

CHAPTER VIII.

DIGESTION.—THE CONVERSION OF FOOD INTO TISSUES.

115. So far, we have studied the structure and uses of the bones, muscles, fat, and skin. We are now to consider various structures for the most part within the skeleton; viz., the digestive organs, heart, blood-vessels, lungs, etc.; and, in connection with these structures, those processes which, because of their importance, are ordinarily distinguished as the vital processes,—such as digestion, circulation, respiration, and the production and maintenance of animal heat and nervous energy.

116. The maintenance of life depends upon the vitality of the innumerable cells of which each body is composed, and this vitality is largely influenced by food.[1] "From the food the blood is fed; from the blood the tissues are fed." The conversion of food in the body into blood is called *digestion*. The digestive organs consist of the alimentary canal and its accessory organs.

117. The *alimentary canal* is a muscular membranous tube, in adults from 25 to 30 feet in length, or about five times as long as the entire body. It begins at the mouth, and extends downward throughout the body. In it the digestion of food is performed. It is lined throughout its

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[1] See, in Introduction, remarks about "cell life."

entire length with a delicate but firm tissue, which is continuous with a similar lining of the air passages, the whole

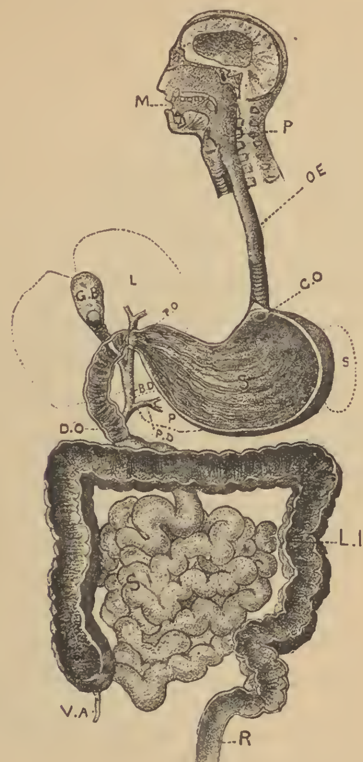

Fig. 32.

The *alimentary canal.*—M, mouth; P, pharynx; OE, oesophagus; S, stomach; CO, its cardiac opening; PO, its pyloric opening; SI, small intestine; VA, verniform appendix; LI, large intestine; R, rectum; GB, gall bladder; BD, bile duct; PD, pancreatic duct; DO, opening of the common duct into small intestines. Accessory digestive organs: L, liver; P, pancreas; S, spleen.

being known as the *mucous membrane*, or "internal skin."[1] This varies in thickness and general arrangement in dif-

[1] From a similarity to the external skin.

ferent portions of the canal, and contains numerous follicles for secretion and excretion, and its surface is covered with cells variously arranged.[1] In addition to the digestive fluids which it secretes, it is supplied with a viscid fluid called *mucus*, which protects it and enables its opposing surfaces to glide easily upon each other in the various movements of the canal incident to digestion.[2] The alimentary canal varies in its different portions in size, form, and structure, thereby forming the mouth, pharynx, oesophagus, stomach, and intestines.

118. The *mouth* and its appendages (the cheeks, lips, tongue, teeth, etc.) are concerned in the earlier steps of digestion, and in health are supplied with a fluid called the *saliva*.

119. Behind the mouth, and at the first bend of the alimentary canal downward, is the *pharynx*. This is, in general, funnel shaped, but with its upper portion, or roof, rounded like a buggy top. It is partly separated from the mouth by a very movable curtain-like muscular flap called the soft palate, to distinguish it from the hard palate, which is the roof of the mouth and is composed of bone covered with mucous membrane. Above and

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[1] In the nose and air passages it is thin and smooth, in the mouth and throat somewhat thicker, upon the tongue it is covered with *papillae*, in the small intestine with very soft projections called *villi*, and in the stomach it is thrown into ridges. The cells covering the surface of the mucous membrane are epithelial cells, and together constitute the epithelium.

[2] Ordinarily, in health, there is just sufficient mucus to act as a lubricant. But in some, young children especially, whose tissues are very sensitive, an excess of mucus is readily induced by an irritation of the mucus membrane, through indigestible food, exposure of the skin to sudden changes in temperature, and by other means. This excess of mucus may, by coating proper food, interfere with its digestion. On the other hand, if the mucous membrane is not torn, injured, or diseased, such an excess by coating improper articles which have been swallowed, — such as coin, — will generally prevent any injury that might otherwise result from them.

behind the soft palate, the pharynx communicates with the nose by two openings, one for each nostril, known as the "posterior nares." In the upper and back portion of

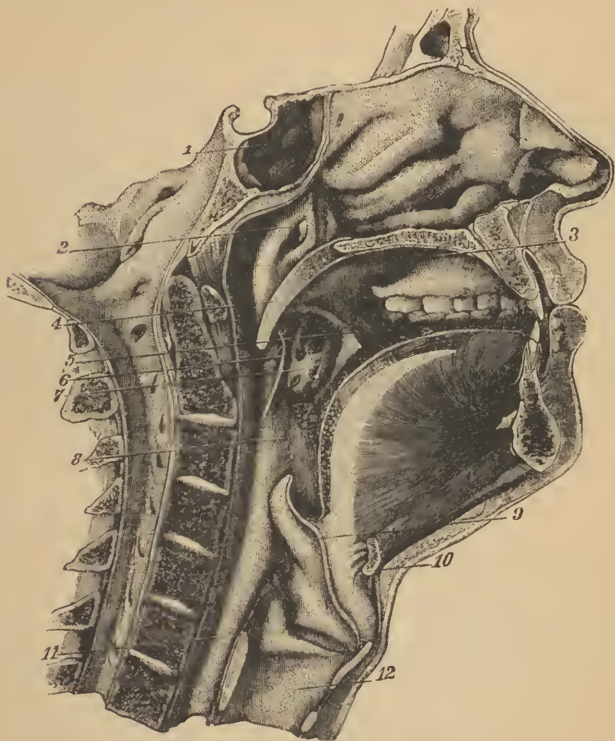

Fig. 33.

A vertical section through the middle of the face, neck, and upper vertebrae.— 1, Cavity in the skull; 2, opening of left Eustachian tube; 3, the hard palate; 4, the soft palate; 5, muscular wall in front of tonsil; 6, muscular wall behind the tonsil; 7, the left tonsil; 8, pharynx, or throat; 9, the epiglottis; 10, the hyoid bone; 11, oesophagus; 12, the cavity of larynx.

the throat, on a line with the "floor of the nose," are the openings of two ducts, named the Eustachian tubes, which connect the mouth with the organs of hearing. At the lower portion of the throat, in front, is the larynx, which

opens into the windpipe. Surrounding the pharynx are three obliquely-placed muscles, styled the constrictors of the pharynx. These overlap each other, and with other muscles are concerned in the act of swallowing.

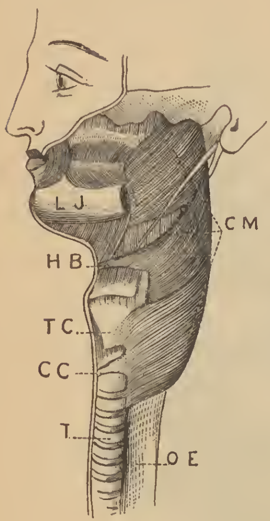

Fig. 34.

The location of the constrictor muscles.—LJ, the front part of lower jaw, the remainder being cut away to show parts beneath; HB, the hyoid bone; TC, thyroid cartilage of larynx; CC, cricoid cartilage of larynx; T, trachea; OE, oesophagus; CM, the constrictor muscles—superior, middle, and inferior.

120. The *oesophagus*, or gullet, is the next portion of the alimentary canal, and connects the pharynx with the stomach. It is about nine inches long, and lies upon the front and upper portion of the spinal column. Its walls contain both longitudinal and circular involuntary muscular fibres, which, by their alternate contraction and relaxation, serve to propel the contents of the oesophagus towards the stomach. The wave-like motion thus resulting is called the "peristaltic" motion, and is similar to that of the intestines.[1]

121. The *stomach* is somewhat pear shaped, its larger end being upon the left side of the body, beneath the ribs, in contact with the spleen, to which it is joined by a ligament of connective tissue. The smaller end is on the right side of the body, under the liver. When moderately filled, the length of the stomach is from thirteen to fifteen inches, and its greatest diameter five inches.[2] Its capacity is about five pints.

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[1] This peculiar motion is also called "vermicular," or worm-like.

[2] Its form and position vary in one and the same individual at different times. When empty, it is shrunken and flattened. In the infant the stomach

The stomach has *two openings:* one where the oesophagus enters, called the *cardiac*[1] opening, because of its location near the heart, from which it is separated by the diaphragm[2]; the other is styled the *pyloric*[3] or "gate" open-

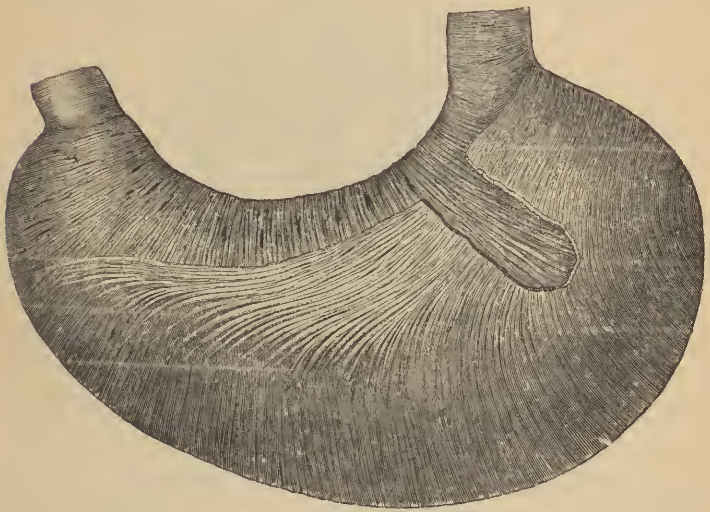

Fig. 35.
The muscles of the stomach, one portion removed to show underlying fibres.

ing, because it is provided with a muscular valve known as the *pylorus*, or "gate-keeper," the object of which is to prevent the premature exit of food from the stomach.[4]

is almost perpendicular at times, hence vomiting is easily induced. The stomach of the glutton becomes distended, and does not readily regain its normal shape, and indigestion results.

[1] Derived from the Greek καρδια, meaning "heart."

[2] When the stomach is over distended, it sometimes presses upon the heart, giving rise to the symptoms of heart disease.

[3] Derived from a Greek word, meaning "gate."

[4] When the stomach contains a large amount of indigestible food, and has been over long in action, its muscular tone diminishes, and the valve is no longer effectual to prevent the exit of improper material. But, fortunately, for this very reason, indigestible substances accidentally swallowed (such as coins, beads, etc.) can, on the relaxing of the muscular activity of the organ, pass the "gate-keeper," though sometimes their passage is greatly delayed and causes much discomfort.

122. The *lining of the stomach* is very soft and delicate. When the cavity is almost or entirely empty, it is arranged in folds. It is amply supplied with blood-vessels,

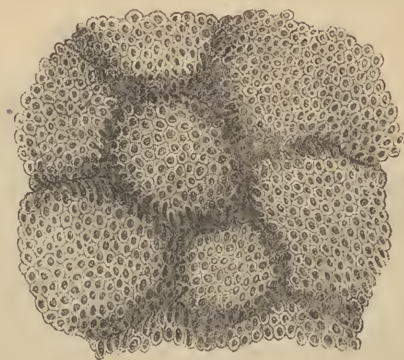

Fig. 36.

The internal surface of the stomach, from which the epithelium has been removed, showing the openings of gastric glands. [Magnified 20 diameters.]

mucous glands, and gastric tubules, or follicles. These last secrete a thin, acid fluid, known as the *gastric juice*. Its quantity is increased by condiments, and its flow facilitated by the odor and appearance of appetizing food; on the other hand, the quantity is diminished by fear, anxiety, anger, grief, etc., and also by that depression which follows excessive eating and drinking.

Fig. 37.—A gastric gland.

The *muscles* in the walls of the stomach, and outside of its mucous membrane, are involuntary, and are arranged in three layers, — the oblique, the circular, and the longitudinal. Their alternate contraction and relaxation serve to agitate thoroughly the contents of the stomach.

123. The remaining portion of the alimentary canal consists of the intestines, or "bowels," which occupy the abdominal cavity, and are divided into the small and large intestines, — the former being from twenty to twenty-five, and the latter about five feet in length.

124. The *small intestine*, so named on account of its calibre, is a cylindrical conduit, coiled upon itself and extending from the pylorus to the large intestine, its opening into which is guarded by the ileo-coecal valve,[1] an arrangement which readily admits of the passage into the large intestine of refuse material, but interposes a very considerable barrier to its return. In the walls of the intestine, throughout nearly its entire length, are involuntary muscular fibres, which are abundantly supplied with a network of nerves.[2]

The intestine is held in place by the mesentery, which is a double fold of serous membrane[3] attached to the spinal column; but it so envelopes the intestine that its necessary peristaltic movements in the transmission of food are not interfered with.[4]

The *lining of the intestine* is very vascular and velvety, and throughout the larger part of the canal is arranged in transverse shelf-like folds more or less circular in form;

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[1] See Fig. 32.

[2] "Invariably the contraction of the muscular tissue, like that of every form of voluntary and involuntary muscle, takes place under the influence of the nerves. Besides the nerves, distributed in networks and plexuses to the mucous membrane and muscles in great number, there is a highly complex system of ganglia, or nerve-centres, little appreciated, and indeed hardly known to more than a few observers. . . . So numerous are the fine nerve-fibres, that there is not a portion of tissue the $\frac{1}{500}$th of an inch in width which does not receive an abundant supply." — *Slight Ailments.* L. S. BEALE, M.D.

[3] A membrane which secretes a thin whey-like fluid called *serum*.

[4] A similar membrane, under the name of the *peritoneum*, encloses, for the most part, all the abdominal viscera in the same way.

which, from their winking motion as they sway backward and forward in the fluids of the intestine, are called *valvulae conniventes.* There are about 800 of these delicate folds. They retard the passage of food, and provide a very large surface for secretion and absorption.

The characteristic velvety condition of the mucous membrane is due to its numerous cone-like elevations, presenting an appearance like plush, and known as the *intestinal villi.* There are more than 10,000,000 of these

Fig 38.
Villi of small intestine, with their superficial arteries and veins distended. [Magnified 100 diameters.]

villi. Within them are numerous minute blood-vessels (veins) which empty into a large vein, called the *portal vein*, which conveys to the liver certain products of digestion. They contain also other vessels, known as *lacteals*,[1] which are a part of a wonderful system of vessels distributed throughout the body, called the *lymphatics*.[2]

[1] So called, because during the process of digestion these minute vessels have a white appearance like milk, from a fluid within them called *chyle*. At other times they are not readily discerned.

[2] See § 249.

These lacteals commence probably as blind extremities in the intestinal villi, and empty into the *receptaculum chyli* (*i.e.*, receptacle of the chyle), a pouch lying upon the lumbar vertebrae. This pouch connects with the *thoracic duct*, a tube quill-like in size, which extends upwards and empties into the left subclavian vein, the large vein under the left clavicle, or collar bone.

In the mucous membrane of the intestine are numerous follicles, some of which secrete mucus and some a digestive fluid known as intestinal juice. Within about three inches of the pylorus the duct from the gall bladder of the liver, and that from the pancreas, open into the intestine, admitting the bile and pancreatic juice.

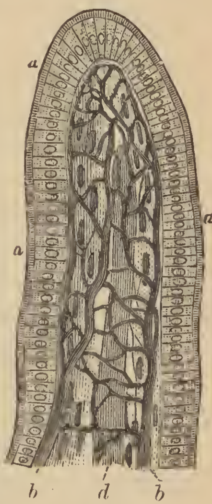

Fig. 39.

A vertical section of an intestinal villus.—*a*, epithelial cells; *b b*, blood-vessels entering and leaving the villus; *d*, lymphatic vessel (lacteal) in the centre.

125. The *large intestine* begins at the ileo-coecal valve, in the right lower portion of the abdominal cavity, ascends upon the right side of the cavity, crosses over to the left underneath the stomach, and descends upon the left side, terminating the alimentary canal. The commencement of the large intestine is styled the *coecum*. This is a rounded cavity, and has a cylindrical tube from one to five inches long projecting from its lower portion, which tube is known as the *appendix vermiformis*. Its uses are not known. Sometimes seeds of small fruit lodge in it, and cause serious disease, which may result in death.

126. The *accessory digestive organs* are the teeth, salivary glands, liver, and pancreas. The *spleen* has, up to

within a recent period, been considered as one of these accessory organs, though its function is not definitely known. The principal effect produced in animals by its removal is an inordinate craving for food. It is now believed that the spleen takes part in the elaboration of blood.[1]

127. The *teeth* are the organs of mastication or chewing. By them the food is thoroughly broken up into minute fragments, and thus prepared for the softening and digestive action of the saliva. They assist also in the use of the voice, and preserve the symmetry of the face. Their position in the jaws is secured by "roots" inserted firmly into sockets, and by the support afforded by the gums, which are composed of dense fibrous tissue, covered with mucous membrane.[2]

The part of a tooth projecting from the gum is known as the crown, and is covered by the enamel, which is the hardest substance in the body. But though capable, ordinarily, of resisting great pressure, it may be broken, and the decay of the teeth rendered probable, by the cracking of hard shell nuts or other hard substances between them.[3]

The bulk of the tooth is composed of dentine, a substance resembling bone, but without canaliculi and lacunae. It is often called tooth-bone or ivory. The

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[1] "The spleen . . . is not immediately concerned with the processes of digestion, and its developmental origin shows it to be unconnected with the digestive organs, although it lies in the abdomen. . . . It is now generally admitted that the functions of the spleen are intimately connected with the work of sanguinification . . . The spleen is most probably one of the seats of formation of the white blood corpuscles and of destruction of the red. It is, in fact, a blood-lymph-gland." — *Quain's Dict. of Medicine*. Wm. Aitken, 1882.

[2] In old people who have lost their teeth, the gums shrink and sometimes become very hard, enabling the owner to munch his food with them.

[3] The hardness of the enamel varies in different persons. In some it is so soft that the teeth wear down almost to the gums.

dentine encloses a cavity in the tooth, which is termed the pulp cavity, and which contains the pulp, a substance consisting of connective tissue, blood-vessels, and terminal nerves. The nerves and blood-vessels enter this cavity through a small opening at the tip of each root.[1] Canals radiate from the pulp cavity to the outer surface of the dentine. Destruction of the enamel at any point, therefore, exposes the entire cavity, and decay results. (*a.*)

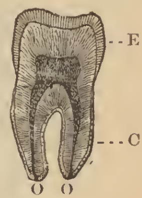

Fig. 40.
A vertical section of tooth. —E, enamel; C, cementum; O, O, openings in roots for the passage of nerves and blood-vessels into the pulp cavity, represented in figure by darkened centre.

128. There are two sets of teeth, — that of early childhood, known as the first, primary, or temporary set, or the milk teeth; and the second, or permanent set, of youth and of adult life.

The *temporary set* has twenty teeth, ten in each jaw. The four in the front of each jaw are the *incisors*, or "cutters." They have chisel-like or wedge-shaped edges, which enable us to bite or cut our food. Adjoining the incisors are the *canines*,[2] one on each side of each jaw. These teeth are somewhat pointed at the edges, after the manner of the teeth of dogs. They assist the incisors in dividing the food. The remaining teeth of the temporary set are the *molars*,[3] or "grinders," two on each side of each jaw. These teeth pulverize the food, and in the permanent set are especially strong. Their grinding sur-

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[1] The pulp supplies nourishment to the tooth. When it dies the tooth loses its translucency and sensibility, and is discolored; and if it be a tooth of the permanent set, is never replaced by a new one, or even by new tooth-structure, but may retain its position in the jaw and do duty for years.

[2] That is, "dog teeth," so called from the Latin *canis*, a dog. The upper canines are sometimes called "eye teeth," the lower ones "stomach teeth," though they have no peculiar relation to these organs.

[3] From the Latin *molaris*, a grindstone.

faces are grooved, and upon them are three or four conical elevations, more or less marked. The first tooth of the temporary set is cut usually about the sixth or seventh month of life, the last about the end of the second year.[1]

The teeth of the *permanent set* are larger and much stronger than those of the first set. They are thirty-two

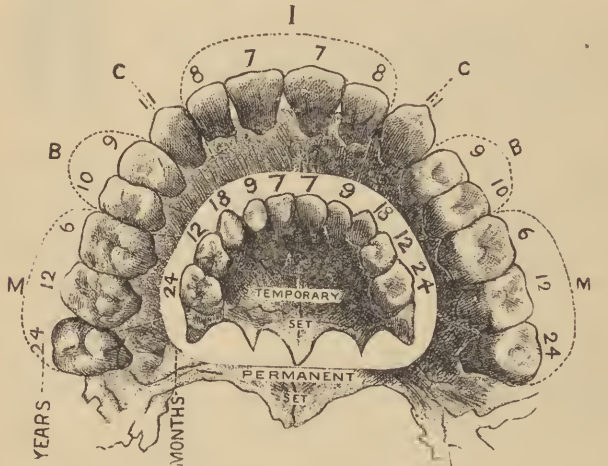

Fig. 41.

A diagram of two upper jaws, representing the location, arrangement, and time of eruption of the temporary and permanent teeth. The relation of the temporary to the permanent teeth is indicated by their position, and by dotted lines connecting them with the permanent teeth. The numerals represent, in one instance, the time of the appearance of the teeth in years; in the other, in months.—I, incisor teeth; C, canine teeth; B, bicuspid teeth; M, molar teeth.

in number,—sixteen in each jaw; viz., four incisors, two canines, four bicuspids,[2] and six molars. The *bicuspids*, found in the permanent set only, are between the canines and molars, two on each side of each jaw. They are shorter and thicker than the canines, and assist the molars

[1] Babies are sometimes born with teeth; but from various causes, such as sickness, hereditary peculiarities, lack of proper tooth-forming food, etc., the appearance of the teeth may be delayed till one year of age, or even longer.

[2] So called, because they have *two* cusps or points upon their crowns.

in crushing the food. The permanent teeth originate near the roots of the temporary teeth, and as they develop, press upon these roots and cause their absorption, the temporary teeth being eventually shed as little conical

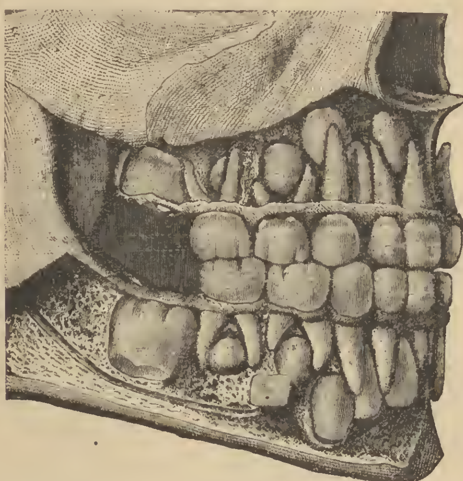

Fig. 42.
Section of jaws, showing the temporary and permanent teeth.

"crowns" with convex bases. The first tooth of the permanent set appears about the fifth or sixth year, and the last, or wisdom teeth, about the twenty-fourth year.[1]

[1] The first permanent teeth appear behind the posterior milk molars, before any of the milk teeth are shed; viz., at six years, so that a child of six has twenty-four teeth, — twenty temporary and four permanent. The permanent teeth usually appear as follows: —

The First molars at the 6th year, sometimes called the "six year" molars.
" Central incisors at the 7th year.
" Lateral incisors at the 8th year.
" Anterior bicuspids at the 9th year, replacing first milk molars.
" Posterior bicuspids at the 10th year, replacing posterior molars.
" Canines at the 11th to 12th year.
" Second molars at the 12th to 13th year, sometimes called "twelve year" molars.
" Third molars at the 17th to 25th year.

129. In mastication, the lower jaw is pressed against the stationary upper jaw with lateral, rotary, and upward movements, by means of powerful muscles. The size and strength of the permanent molars, and their broad and irregular upper surfaces, well adapt them for this grinding action.[1]

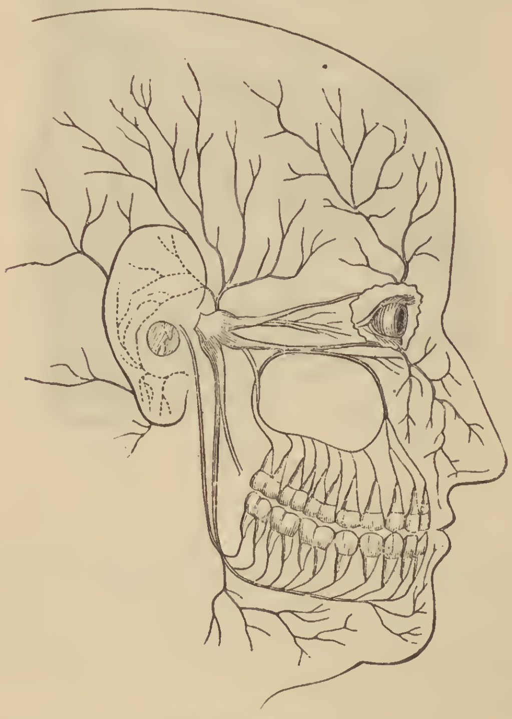

Fig. 43. (White.)
The connection of the nerves of the teeth with the sensitive nerves of the face and head.

[1] These movements of the jaws are very marked in herbivorous animals, such as the cow and horse. In such animals the other teeth are sometimes rudimentary, but the molar teeth are very large, and present broad, grooved surfaces, somewhat like the ridges and depressions in the grinding surfaces of millstones.

The teeth of the human being combine the characteristics of those of the carnivora and herbivora, — that is to say, are adapted for masticating both animal and vegetable food. The first appearance of teeth indicates that other food than milk can now be used, while the cutting of the permanent teeth shows that food which requires much chewing is to be included in a proper diet.

130. It is a popular fallacy that the permanent teeth alone require *care*, and that it is a matter of no importance whether the temporary teeth decay or not. In point of fact, proper care of the temporary set often insures a regular and strong permanent set. The temporary teeth in healthy children should not decay, but should fall out clean and white when their function is ended. They are, however, if not cared for, more liable to decay than permanent teeth, on account of the larger proportion of animal matter they contain. For this reason the condition of the teeth of children should be carefully ascertained, and defects remedied at least twice a year by a reliable dentist.[1] In addition to the difficulty of mastication, and the toothache caused by decay of teeth, an excruciating pain in the side of the face and head (*i.e.*, neuralgia) results, from an extension of the irritation from the small nerve in the tooth pulp to the large nerves of the face and head.

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[1] Cavities in the temporary as well as in the permanent teeth should be filled when possible. The *premature* extraction of a tooth may destroy the symmetry of the jaws, and allow the opposing tooth to grow to an uncomfortable length. In rabbits a tooth thus deprived of its opposing one grows like a tusk. Much can be accomplished by competent dentists towards regulating the direction of the teeth and the shape of the jaws. The excess of animal matter in the osseous tissue of young children accounts for the deformed upper jaws, with the projecting front teeth, which sometimes results from long continued thumb-sucking.

131. Teeth, as well as bones, require a certain proportion of mineral matter, which should be supplied by proper food. They should be kept clean by frequent rinsing with water, and by the gentle but firm use of a small and rather soft brush, especially upon the inner side of the teeth, in the morning and before retiring.[1] Every particle of foreign matter should be removed from between the teeth by a quill or wooden tooth-pick, or, when necessary, by drawing a thread or thin strip of rubber between the teeth.[2]

132. Acid or gritty powders, or mixtures including charcoal, are to be avoided. Prepared chalk, or "camphor and chalk powder," or chalk and orris root, or even common salt, may be used to advantage. If the secretions of the mouth are acid, a mouth wash of a weak solution of sodium bicarbonate (one-fourth teaspoonful to two ounces of water) is serviceable; or, lime water, flavored with liquid extract of licorice. To remove odors, a wash of two or three drops of carbolic acid in a half tumbler of water, or a solution of common salt, is useful.

133. Of the accessory organs of digestion, the next to be considered are the *salivary glands*. The most important of these are: 1st. The *parotids*,[3] one in front of and below each ear, with a duct opening into the mouth about opposite each second upper molar tooth. 2d. The two *submaxillary* glands, just within the angles of the lower jaw,

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[1] Frequent scrubbing of the teeth with large and hard brushes is injurious.

[2] Pins, knife-blades, and other metallic substances should never be used as tooth-picks, for they are liable to injure the enamel.

[3] Called *parotid*, from two Greek words meaning *near the ear*. These glands are sometimes called masticatory glands, as they are only found in animals furnished with grinding or masticating teeth. The disease known as *mumps* is an inflammation of one or both of these glands.

whose ducts open under the tongue at its junction with the under surface of the mouth. 3d. The two *sub-lingual*, which are the smallest of the salivary glands, and are situated under the tongue, and discharge their secretion by ducts near the opening of the ducts from the sub-maxillary glands.[1]

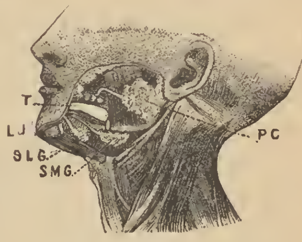

Fig. 44.
Diagram showing the location and relations of the salivary glands of the left side, a large part of the lower jaw being removed. — T, the tongue; LJ, part of the lower jaw; PG, the parotid gland; SLG, the sub-lingual gland; SMG, the sub-maxillary gland.

The secretions from these glands, together with that from the glands of the general mucous surface of the mouth, constitute the *saliva*. This secretion is a thin alkaline fluid, whose function it is to dissolve sapid particles of food, thus enabling us to taste, to soften food so that it may be the more readily chewed and swallowed, to keep the mouth moist and lubricated, and, finally, to transform some of the starch in food.

From one to three pounds of saliva are secreted per day in a man of average size, the quantity increasing with the hardness and dryness of the food. It is also increased by the movements of the lower jaw in mastication, by anything introduced into the mouth, but especially by those things which stimulate the sense of taste. Its flow is largely under the influence of the nervous system. On the one hand, the mere thought or smell of agreeable food will "make the mouth water." On the other, under the influence of anger, fear, etc., the tongue, in its dryness, is said to "cleave to the roof of the mouth."

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[1] Sometimes, by looking into a mirror at the reflection of one's open mouth, the tongue being raised, drops of saliva may be seen to issue from the openings of the ducts under the tongue.

134. The *pancreas* is an elongated fleshy organ near to, and just behind the stomach. It secretes the *pancreatic juice*, a viscid, alkaline fluid which is poured into the upper portion of the small intestine, as before stated. It acts principally upon the fat in food.

135. The *liver* is the largest gland in the body. It secretes the bile, which is carried by a multitude of fine canals within the substance of the liver into a main tube which opens into the upper part of the small intestine, as before described. Part of the bile, however, passes through a branch of this main tube to the *gall bladder*, there to be stored for future use. This reservoir is a pear-shaped bag, about three inches in length, attached to the under side of the liver.

In addition to the secretion of bile, the liver has another function, which has, within the last few years, been especially studied; viz., the "glycogenic" or "sweet producing" function, so named from the substance called *glycogen.* Glycogen is formed in the liver from the digested materials brought to that organ by the portal vein, but is derived mainly from the starch and sugar absorbed in the digestive process. It is formed during digestion and stored in the liver, to be gradually transformed, in the intervals of digestion, into glucose, or a sugar similar to grape sugar.

136. The *bile* is of a bright yellowish-green color, and is constantly secreted; but the flow is increased soon after digestion in the stomach begins. About two and a half pounds are secreted per day. The importance of the bile is shown by the results of experiments upon the lower animals, and by the disturbed conditions following an interruption of its usual supply in the human being. If the bile be not secreted, or be prevented from entering

the small intestine, an animal will become very feeble and emaciated, and even die. It is known that the bile assists the pancreatic juice in preparing fat for absorption, that it assists in the prevention of decomposition and putrefaction of food during its passage through the intestines, and that it increases the muscular action of the intestines. It is in part thrown off as an excretion, while some of its constituents are re-absorbed, to be converted into carbonic acid and water.

137. The various steps by which *food is converted into the tissues of the body* are: Mastication, Insalivation, Deglutition, Stomach and Intestinal Digestion, Absorption, Circulation, and Assimilation.

138. When food has been received into the mouth, and cut and torn by the incisor and other teeth into appropriate pieces, it is then *masticated* or chewed, and for this purpose, by the action of the tongue, lips, and cheeks, is rolled about the mouth and placed between the lateral teeth, especially the molars, and is mashed and ground up into minute fragments. At the same time it is softened by *insalivation*, or a thorough mixture with the saliva; and during this process part of the cooked starch in the food is changed into dextrine, and then into glucose, and is thus rendered soluble. (*a.*)

This change is effected by the *ptyaline* of the saliva, an organic ingredient, which acts as a ferment; *i.e.*, by its presence, under the favorable circumstances of heat and moisture, it changes the chemical constitution of a substance for which it has an affinity.[1] The action of yeast in bread-making is a good illustration of the action of a ferment. The change in starch begun in the alkaline

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[1] Ferment action is sometimes spoken of as catalytic action, or catalysis.

secretions of the mouth probably ceases as the food reaches the stomach, but is resumed amid the alkaline secretions in the small intestine.

139. The food having been properly prepared, is then moved towards the pharynx to be swallowed. The final steps in *deglutition* are involuntary. As the food or drink enters the pharynx, it is grasped by the constrictor muscles and hurried on into the oesophagus,— the openings leading to the lungs, nasal cavities, and ears being usually protected from its ingress by the approximation of their walls, and by the raising of the soft palate. If the mechanism of swallowing is disturbed by excessive laughing or talking, or by rapid swallowing, food, especially the fluid portion, is liable to enter the larynx or nose, and cause coughing, sneezing, and sometimes serious results unless prompt aid be furnished.[1]

The passage of the food or drink to the stomach is effected by means of the peristaltic action of the oesophagus. This action is sufficiently powerful to overcome the laws of gravitation. Hence, liquids and solids may sometimes be swallowed indifferently in all positions of the body.[2]

140. Just as soon as the food reaches the stomach, *stomach digestion* begins. The mucous membrane, which in the intervals of digestion is of a pale red color, now becomes bright red from its engorgement with blood. The gastric juice is poured out in abundance.[3] It dissolves the

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[1] Sometimes, for example, particles of meat going the "wrong way," lodge in the larynx and cause death by suffocation. (See EMERGENCIES, p. 321.)

[2] Even standing on the head, as jugglers often do.

[3] A portion of the gastric secretions (*i.e.*, gastric juice and mucus), intermingled with the softened and partly digested food, passes into the intestines, while the remainder is absorbed by the mucous membrane of the stomach, to be again secreted when necessary.

connective tissue of meat, releases fat from its envelopes by breaking them up, and transforms some of the albuminous material, such as lean meat, the gluten of wheat, and white of eggs, into albuminose, in which form such articles are capable of being absorbed.[1] This transformation is effected by the ferment action of an organic ingredient of the gastric juice known as *pepsine*,[2] in connection with an acid ingredient; for, if this acid be neutralized by an alkali, pepsine is of little value.

141. While the above processes are being carried on, the fluid portion of the food, both that which has entered the stomach as fluid, and that which has been liquefied by stomach digestion, is rapidly taken up by the absorbents of the stomach and carried into the blood, while the more solid portions are thoroughly intermingled with the gastric secretions by the churning action of the muscles of the stomach.

142. The unabsorbed food begins slowly to leave the stomach in about half an hour after its introduction, in the form of a gray semi-fluid, usually called *chyme*. This is a mixture of some of the sugar and salts of the food, of transformed starch or glucose, of softened starch, of broken fat and connective tissue, and of albuminose.

143. The entire digestion of an ordinary meal in the stomach requires from two to four hours.[3] Some foods are thoroughly digested, so far as the stomach is concerned, in one hour, and some require as much as five hours. (*a.*)

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[1] The term "peptone" is also applied to albuminous material which has been rendered soluble by digestion.

[2] Pepsine, obtained generally from the stomachs of pigs, is used as an artificial digestant in certain forms of dyspepsia.

[3] Substances more or less indigestible are acted upon with difficulty. Sometimes they are thrown up, or pass, after many hours, into the small intestine, causing suffering.

The duration of stomach digestion varies also in different persons, and in the same persons at different periods. It depends in a great measure, not only upon the kind and quantity of food taken, but also upon the condition of the nervous system, the amount of exercise, etc.

144. The chyme, upon entering the intestine, comes in contact with the bile and the pancreatic and intestinal juices. *Intestinal digestion* now commences. By means of these various fluids most of the food not already softened is dissolved. The transformation of starch into glucose is continued by the action of the pancreatic and intestinal juices.[1] The change of albuminous materials into albuminose is now completed by the pancreatic, assisted probably by the intestinal secretions, while fat is broken up into minute globules, and an emulsion formed by the pancreatic juice, assisted, as some believe, by the bile.[2]

From the digestion in the small intestine there result "three different substances; viz.: 1st. Peptone, from the digestion of albuminous matters; 2d. Chyle, from the emulsion of the fats; and 3d. Glucose, produced by the transformation of starch."[3] These substances are, to a large extent, carried into the blood and become a part of it, while the undigested food passes on into the large intestine.[4]

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[1] The opportunities for the study of intestinal digestion have been fewer than for that of other portions of the digestive tract; hence, less is known about it, and at the present time (1884) there is reason to believe that intestinal digestion is more complicated than it has been supposed to be. The pancreatic juice, for example, is believed to have *three* active principles, — one to digest starch, one to act upon flesh and similar foods, and one to "cause the decomposition of the neutral fats with the liberation of a fatty acid."

[2] "Pancreatine," obtained from the pancreas of animals, is much used as an artificial digestant.

[3] DALTON'S *Human Physiology*. 7th edition. 1882.

[4] The passage of the food through the small intestine is said to occupy, on the average, about twelve hours.

145. *Absorption*, or the process by which liquefied and transformed food is taken up by the veins and lacteals, is effected by endosmosis.[1] By the blood-vessels of the stomach, water, and whatever is dissolved in the gastric juice, — viz., some of the albuminoids, sugars, and salts, — are rapidly absorbed and carried by the blood in the portal vein to the liver, together with the peptone, glucose, and molecular fat which has reached the portal vein through the blood-vessels of the intestinal villi. This blood, after traversing the liver, reaches the right side of the heart. On the other hand, the chyle, consisting mainly of emulsified fat, but combined with other digested materials, passes through the lacteals into the thoracic duct, together with the "lymph"[2] from the lower portions of the body, and is conveyed to the left subclavian vein, and so into the blood.[3] (Fig. 45.)

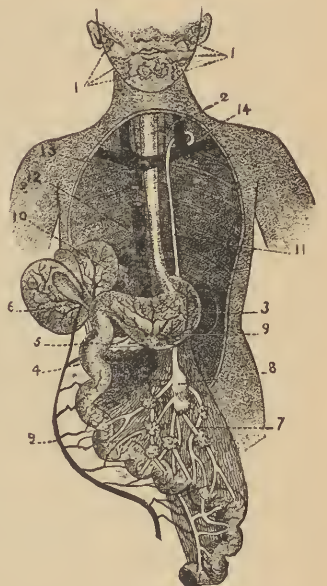

Fig. 45.

A diagrammatic representation of the various organs concerned in the conversion of food into blood. — 1, The salivary glands; 2, the oesophagus; 3, the stomach; 4, a portion of the small intestine; 5, pancreas; 6, the liver; 7, the lacteals; 8, receptacle of the chyle; 9, the portal vein and its branches; 10, hepatic veins leading from the liver to the large ascending vein; 11, the thoracic duct; 12, the large ascending vein, cut off at its junction with the heart; 13, the large descending vein, cut off in like manner; 14, the thoracic duct emptying its contents into the left subclavian vein.

[1] See Introduction, § 8.

[2] A fluid containing some of the results of the decay of tissues, which is conveyed to the blood by the lymphatics.

[3] It is said that the mixed lymph and chyle move through the thoracic duct at the rate of about twelve inches a minute, that the flow is aided by valves in the duct, and that about six lbs. pass through in twenty-four hours.

146. The process by which the blood carries the digested materials to the various tissues of the body is known as the *circulation*, and that by which each cell and tissue appropriates material so brought for its growth and development is termed *assimilation*.

147. The *changes* which the transformed and digested food undergoes after it reaches the blood may be stated as follows: Albuminose is in all probability, for the most part, converted into the albumen of the blood and the albuminous portions of the tissues, and is discharged from the body in the excretions as urea, creatinine, etc. Glucose (resulting from the digestion of sugar and starch) and fatty matters, after serving in the main to build up the adipose and other soft tissues of the body, are eliminated chiefly as carbonic acid and water. On the other hand, water and the mineral ingredients of food, as a rule, pass through the system unchanged after having afforded necessary fluidity, strength, or alkalinity to various tissues and fluids, as the case may be.

148. In healthy digestion the food which cannot be assimilated or converted into heat, energy, and strength, is ordinarily eliminated with ease by the excretory organs. But, if the bodily powers be overtaxed by food, inappropriate as to quantity or quality, the extra eliminating work demanded, especially of the kidneys and liver, may seriously derange the overtaxed organs.

149. For digestion to be normally carried on, it is evident, from what has already been said, that the digestive organs must be normal in structure and capable of the necessary muscular movements. Their secretions must be perfect as to quality and quantity. Gastric juice, for example, will not act as a solvent if its acid is neutralized

by an alkali. So of the pancreatic and intestinal juices, if their alkaline nature is destroyed by the undue presence of acids.[1]

The food also must be just sufficient, and so cooked or otherwise prepared that it can be acted upon with ease by the digestive organs and their secretions. It must be thoroughly chewed, with freedom from anxiety, slowly swallowed, and be taken at regular intervals, and not immediately before sleep or great physical or mental effort. Broken or decayed teeth, or a defective number of them, sore mouth or throat, neuralgia of the face, the waste of saliva by the habit of expectoration, torpidity of the muscles of the alimentary canal, defective action of the glands concerned in digestion, impediments in ducts, etc., all interfere with proper digestion and nutrition.[2]

QUESTIONS.

1. What processes are generally termed "vital," and how are they essential to the maintenance of life?
2. What is digestion, and what are the digestive organs?
3. Describe the alimentary canal, and name its different portions.
4. What begins the alimentary canal, and what is there secreted?
5. Describe the pharynx, and state what opens into it.
6. What are the constrictors of the pharynx, and their object?
7. Describe the oesophagus, and its object and mode of action.
8. Describe the stomach and its openings.
9. How are the intestines divided? Describe the small intestine.
10. What is the mesentery, and its use?
11. How is the movement of the food in the intestine effected?
12. Describe the mucous membrane of the intestine, and state its object, and how it is increased in extent.

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[1] The lesson of *moderation* in the use of alkalies and acids is self-evident.

[2] Hence, it will be readily appreciated that difficult digestion, or "dyspepsia," demands for its relief something more than specific medicines.

13. What gives it its plush-like appearance? Describe the villi, and state what they contain.
14. Describe the lacteals.
15. Of what use are the follicles in the mucous membrane of the intestine?
16. What secretions enter the intestine near the pylorus, and from what?
17. Describe the large intestine, the coecum and its appendage.
18. What are the accessory organs of digestion?
19. What are the uses of teeth? Name and describe the different parts of a tooth.
20. What kinds of teeth are there, and what are their different uses?
21. How do the jaws act in chewing?
22. What do human teeth indicate as to the proper food of man?
23. Why should care be taken of the temporary or first set of teeth?
24. How should teeth be preserved?
25. Describe the salivary glands, and their secretion.
26. Describe the pancreas and its secretion.
27. Describe the liver and gall bladder.
28. Describe the secretions of the liver.
29. What are the various steps in the process of the conversion of food into tissue? Describe them.
30. What is the chyme? The chyle?
31. How are the fatty matters in food converted into an emulsion?
32. Where does absorption take place, and by what processes are substances taken out of the alimentary canal?
33. How do the absorbed products of digestion reach the general circulation?
34. What changes are effected after they have reached the blood?
35. What is assimilation?
36. What is necessary to healthy digestion?

ANALYSIS OF THE EIGHTH CHAPTER.

DIGESTION.—THE CONVERSION OF FOOD INTO TISSUES.

- I. ORGANS
  - Alimentary canal
    - Mouth.
    - Pharynx.
    - Oesophagus.
    - Stomach.
    - Small intestine.
    - Large intestine.
  - Accessory organs
    - Teeth . .
      - Uses.
      - Structure.
      - Varieties
        - Incisors.
        - Canines.
        - Bicuspids.
        - Molars.
      - Arrangement.
      - Preservation.
    - Salivary glands
      - Parotid.
      - Sub-maxillary.
      - Sub-lingual.
      - Of the mucous membrane of the mouth.
    - Liver
    - Pancreas
    - Organs of absorption,—veins & lacteals.
    - Organs of assimilation,—cells.
- II. STEPS OR PROCESSES . .
  - Mastication.
  - Insalivation.
  - Deglutition.
  - Stomach digestion.
  - Intestinal digestion.
  - Absorption, Assimilation — Circulation.

CHAPTER IX.

FOOD. — DIETETICS.

150. The term *food* in a physiological sense includes all substances, solid or fluid, which, when introduced into the system, will nourish some part of it, or will supply heat, or nervous or other animal force, or aid in the due discharge of the various processes which take place in the body. Some kinds of food — preëminently milk — will accomplish all these results.

151. Food, both that which directly sustains cell life by supplying material for cell growth and development, and also that which, like the fuel of an engine, is converted into heat and force, is sometimes called *positive food*. Substances which assist the vital processes by facilitating the assimilation of other substances, or by retarding the waste of tissues, are known as *negative foods*.

152. Food is furnished to us by all the kingdoms of nature; and, as our knowledge extends, new food products are discovered. It is worthy of note that the ordinary food supply of different countries varies in kind and quantity,[1] and that substances highly esteemed by some portions of our race are repulsive to us, while some

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[1] "Lists of possible eatables are most interesting to the student of human nature; they lead to inferences as to the action of laws, religions, customs, and associations, in making that abominable to one race which is most highly appreciated by another; and they are an important part of the arguments of those who trace political events and national character to physical causes." — *Manuel of Diet*. THOMAS KING CHAMBERS.

of our most valued foods are considered by others as even poisonous.[1] Unlike the lower animals, man can prepare by sifting, grinding, cooking, etc., such food as he cannot or does not care to eat in its natural state; and is enabled to remove what may be hurtful, and to retain for himself what is beneficial.

Much, however, that is indigestible and innutritious in food substance is more or less important, in moderate amount, to stimulate the digestive organs. Food too much refined, or deprived altogether of coarser ingredients, such as bran and the skins of small fruits, is not the best adapted to persons in health. (*a.*)

153. Food may be considered as *organic* and *inorganic*, — or, that which is obtained from living organisms, whether animals or plants, and that which is derived directly from unorganized bodies, as air, water, and earth. The chemical elements of which the human body is composed, and which must therefore be supplied to it by food, are said to be fourteen in number.[2] The principal of these are nitrogen, carbon, oxygen, and hydrogen.

154. Organic food substances are divisible into two groups of alimentary principles or constituents; viz., the *nitrogenous* or *albuminoid*, and the *non-nitrogenous* or *carbonaceous.* The first group comprises such substances as albumen, fibrin, and casein. They are called nitrogenous

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[1] Certain tribes of Indians in South America eat at times a peculiar kind of clay. Beetles were eaten by Roman epicures, and are said also to be eaten by Turkish women for the purpose of fattening themselves. Bees, moths, ants, mice, and many small animals form staple articles of diet in some parts of the world. Humboldt tells us that centipedes are eaten with avidity by some of the natives of South America.

[2] The elements are: Oxygen, hydrogen, nitrogen, carbon, phosphorus, sulphur, silicon, chlorine, fluorine, potassium, sodium, calcium, magnesium, and iron.

because they contain nitrogen.[1] From their resemblance to albumen, the most prominent member of the group, they are also called albuminoids. The second group comprises fats, sugars, and starches, which are distinguished as non-nitrogenous or carbonaceous, because they do not contain nitrogen, and have carbon as a prominent ingredient.[2] There are a few organic alimentary principles which cannot be grouped as above; such are the vegetable acids and pectin, or vegetable jelly. The *inorganic food substances* comprise water and various chemical salts, the principal of which are common salt, and the salts of soda, potassa, and lime.

155. *Albuminoid compounds* exist not only in nearly every animal fluid and tissue, but also in vegetables, especially the cereal grains; and accordingly these grains may sometimes be substituted for animal food. While the nitrogenous constituents of vegetable food are similar to those in animal food, their relative quantity is much smaller, and the indigestible residue of vegetable food is much larger in amount.

156. From the presence of albuminous substances in the animal economy, the necessity of a due supply of albuminoids in food is self evident, yet *they cannot of themselves alone support life.* Animals fed exclusively on any one of them lose appetite, become emaciated, and die of starvation. Though they are of great importance, and

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[1] Besides nitrogen, they contain oxygen, hydrogen, and carbon, and in some instances, (as in albumen, fibrin, and casein), sulphur also. They are sometimes called "proteids," "protein compounds," "proteinaceous alimentary principles," "organic substances proper," etc.

[2] The fats are sometimes spoken of as the hydro-carbons, and the starches and sugars as carbo-hydrates. The terms "calorific," "combustibles," "respiratory," "fat forming," and "heat producing," are sometimes applied to the "second group" of organic food constituents. They are composed of carbon, hydrogen, and oxygen.

exhaustion follows more rapidly when they are withheld than when the body is deprived of certain other food constituents, yet to distinguish them as "the nutritious" elements of food is misleading.[1]

The more permanent tissues of the body are undoubtedly more readily constructed from the albuminous than from the carbonaceous food substances, and by the conversion of the former into tissues, force is mainly produced. Still, recent researches by Fick, Wislicenus, and others show that the changes carbonaceous foods undergo in the body not only afford the most heat, but considerable force also.

157. Albuminous substances can be eaten for a longer time without loathing than most other food constituents. The foods which contain them, especially meat, are also for the most part palatable, and give us the "sensations of energy, of feeling up to the mark, of being equal to work, which are so pleasant to all." (*a.*) Hence they are apt to be consumed in too large quantities, and the stimulus afforded by such food is quite often obtained at the risk of biliousness and gout, for the waste products, resulting from the digestion of so much nitrogenous food, are not thoroughly eliminated from the body, and act as poisons in the blood. Especially is this the case if there is insufficient exercise, if the digestive secretions are not sufficiently abundant or active, or the liver and kidneys are not in healthy working order.

158. The nitrogenous constituents are not crystallizable; they exist mainly in a fluid or semi-solid condition; they

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[1] The idea that albuminoids were alone the "tissue making," "flesh forming" or "plastic," and therefore the "nutritious" elements, has been taught by physiologists until recently. It was advocated by Baron von Liebig, who was among the first to attempt a scientific classification of food.

coagulate, *i.e.* become solid, under certain conditions, for example, on exposure to air, heat, or acids; under favorable circumstances they act as ferments, and are themselves liable to putrefy and to transformations under the influence of ferments.[1] The process of putrefaction, by which the substances soften, liquefy, and decompose, requires for its inception and continuation, access of atmospheric air, or of some fluid containing oxygen, the presence of moisture, and a moderately elevated temperature. The process is accomplished by the growth and multiplication of a microscopic vegetable organism belonging to the genus bacterium. Canning of food, especially if it has been partially cooked, desiccation, or thorough drying, freezing, and also heating to about the temperature of boiling water, are methods by which the decomposition of albuminoid matter and the activity of bacteria can be prevented, and the preservation of food effected. (*a.*)

159. The principal albuminoid constituents of animal food are albumen, fibrin, and casein; of vegetable food, albumen, gluten, and casein.[2]

Albumen is found in flesh, blood, milk, seeds, and grains, but its purest form is the white of eggs.

Fibrin[3] is found in the blood, lymph, and chyle, and in some of the semi-solid animal tissues, and in some of the vegetable juices. From bones there is extracted an

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[1] Casein of milk, for instance, after exposure for a time to a warm atmosphere, becomes a ferment, and sours the milk by converting the sugar of the milk into lactic acid.

[2] Other albuminoid constituents are: myosine, in muscle; chondrine, in cartilage; and elastine, in elastic tissue. There are also the ferments, ptyaline, pepsine, etc., and coloring matters such as the hemoglobine of the blood, bilirubine and biliverdine of the bile.

[3] Within the last few years physiologists have been led to believe that the term "fibrin" should be alone applied to the coagulated ingredient "fibrinogen."

albuminous principle known as *gelatine*, which is often given to invalids in the form of jelly.[1]

Gluten exists in variable quantity in the cereal grains, being most abundant in wheat (10 to 35 per cent). It is this that gives to dough its adhesive character. It is a highly nutritious compound, and is composed of vegetable albumen, fibrin, and casein, together with oil and inorganic matter.[2]

Casein exists in milk, and in a coagulated form becomes cheese. It is also extracted from beans, peas, and similar vegetables, and is then known as vegetable casein or "legumine."[3]

160. The organic non-nitrogenous food constituents — fat, sugar, and starch[4] — are of more importance than is generally believed. The Tyrolese chamois hunters, it is said, find that they can endure greater fatigue with beef fat as their food than with the same weight of lean meat. The strength of the Hindoo and of the Irishman, the one living mainly on rice and the other on potatoes, is well known. Still, the amount necessary of such foods to furnish that strength is very large in comparison with that

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[1] In 1841 the physiologist Magendie, in connection with a French committee of investigation, showed that animals fed on pure albumen, fibrin, or gelatine, lost their appetites and died, with all the evidences of starvation, about the twentieth day. On the other hand, raw bones, containing, as they do, fat, albumen, water, and salts, as well as gelatine, are capable of supporting life.

[2] By the gelatine committee referred to above, it was proved that dogs could live and be nourished on gluten alone for an indefinite time. Pereira says of it, "Gluten is easy of digestion, and substances which contain it largely are readily digested by invalids and dyspeptics."

[3] "The article called *tao-foo*, made by the Chinese from peas, is apparently identical with cheese." — *Text-Book of Physiology*. FLINT.

[4] These constituents were called by Liebig the *respiratory*, from his belief that in the body their carbonaceous elements were the sole sources of heat, and only useful to produce it by being slowly burned up in respiration by contact with the respired oxygen of the air, just as heat in ordinary combustion is produced by the combination of the carbonaceous materials of wood, coal, fats, oils, etc., with the oxygen of the atmosphere.

required by a mixed animal and vegetable diet. Necessary as the organic non-nitrogenous constituents are, like the albuminoids and other alimentary principles, *none of them of themselves will support life.*

161. *Fat* is chiefly obtained from animals in the form of adipose tissue, the cream of milk, or as fish oil. Many vegetable substances also contain fat, especially oats and Indian corn, cocoa, beans, walnuts, butternuts, and the berries of the olive tree. The digestibility of fat varies with individuals, and with the kind eaten; some persons dispose easily of that of bacon or beef, while others readily digest fresh butter only. Animal fat is, as a rule, not so easily digested as vegetable oils. Some kinds of fat, not being pure, easily decompose on exposure to air; or, on being heated, acids are produced which sometimes prove very indigestible and irritating if received into the system.

The heat-producing property of fat renders it especially valuable in cold weather and in cold climates, where it is eaten by the inhabitants in enormous quantities, four to five pounds per day being the ordinary amount for the average adult. (*a.*) Sailors, who may be averse to fatty food, when wintering in the Arctic regions, as a rule, learn to drink freely of oil, and to enjoy the fat portions of the seal, walrus, and other marine animals. On the other hand, fat is much used in hot countries in the shape of vegetable and fish oils, especially when meat is scarce or is prohibited by religious opinions. (*b.*)

162. Fat is especially necessary when growth is most rapid; for its presence in the body seems to be *essential to cell growth.* It is claimed by many eminent physicians that fat eaten in sufficient quantity is a preventive of much of that defective nutrition which finally ends in

chronic nervous diseases, and in scrofula and consumption.[1] On the contrary, too large a quantity of carbonaceous food, sugar and starch as well as fat, is not readily disposed of in the body, but produces skin eruptions, unduly increases the adipose tissue, especially about the heart and other organs, and thus impairs health.

163. *Starch*, when pure, is a fine white powder, which under the microscope is seen to consist of granules. These vary in size and form, according to the kind of starch.[2] Starch is found distributed through the vegetable kingdom in cells and among fibres, in tubers, seeds, stems, and fruit. It is especially abundant in the cereals, also in potatoes, chestnuts, beans, peas, and lentils.[3] Arrow root, tapioca, and sago, which are extractions from various plants, are nearly pure specimens of starch.

164. Starch is not affected by cold water. But if heated with water, the granules absorb it, swell, and form a mucilaginous mass or stiff jelly. When boiled with several times their volume of water, the granules burst,

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[1] "This is probably one of the reasons of the craving of children in our climate for butter, which presents oily matter to the digestion in an easily assimilable form, and is evidently a valuable dietetic agent."

It is probably true that most of the persons who are benefited in this country by cod-liver oil, in Switzerland by neat's-foot oil, and in Russia by train-oil, would not need these oils as medicine if their food had contained sufficient oil or fat.

[2] "They cannot be distinctly seen with the naked eye, and are so extremely minute that the finest wheat flour, which has been ground to an impalpable dust, contains its starch granules mostly unbroken and perfect. The granules of potato starch are the largest, while those of wheat and rice are much smaller, varying all the way from the $\frac{1}{300}$th to $\frac{1}{10000}$th of an inch in diameter. Assuming the grains of wheat starch to be $\frac{1}{1000}$th of an inch in diameter, a thousand million of them would be contained in a cubic inch of space." — *Hand Book of Household Science.* YOUMANS.

[3] "It forms at least one-seventh of the whole substance of the potato, about one-third of peas and beans, over one-half of wheat, rye, and oats, and at least three-quarters of rice and Indian corn." — DALTON'S *Treatise on Human Physiology.*

become transparent, and lose their individuality. On cooling, a homogeneous pasty mass is formed, in which the granules are not visible.

By the absorption of water and subsequent cooking, the starch is partly changed into dextrine, in which form the necessary process in digestion, of conversion into glucose by means of the saliva and intestinal juice, is more readily effected. Hence, starchy foods are most digestible when thoroughly cooked. During the process of germination of fruits and vegetables, a part of their starchy contents is also changed into dextrine by the action of a peculiar vegetable substance known as *diastase*. It is for this reason mainly that ripe fruit is more digestible than unripe.

165. Though starch is, in general, promptly transformed by the digestive process, yet, if taken in a very large quantity, or too frequently, to the exclusion of other food material, fermentation results, and the appetite is weakened and digestion impaired. Persons, therefore, living chiefly on bread and tea, or on bread and potatoes, or, as sometimes happens in the case of young children, upon arrow root and corn starch, often suffer from an "acid stomach." For these reasons starchy foods should be given sparingly, if at all, to children under four months of age; that is, until a sufficiency of saliva and intestinal juice is secreted.

166. Entering into the composition of certain vegetables are substances allied to starch, but differing somewhat as to properties, and having comparatively but little value as food. Of these, gum, mucilages, and pectin, or vegetable jelly, are examples.[1]

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[1] These substances are sometimes classified as the *amylaceous compounds*, *i.e.* resembling starch, — to distinguish them from the oleaginous group of substances; viz., fats and oils, and the saccharine group, — or the sugars. Cellulose, lichenine and inuline, besides many other substances, belong to the amylaceous compounds.

167. *Sugar* is closely related to starch in chemical composition, but is distinguished by its sweet taste, its solubility in water, and the crystallization which occurs upon boiling a watery solution. Some varieties of sugar readily ferment, that is to say, decompose and are converted into alcohol and carbonic acid, on exposure to heat and moisture, or in the presence of an organized substance known as yeast.

There are several varieties of sugar. The most important of these are *cane sugar*, *glucose* or *grape sugar*, and *milk sugar*.[1] Of these varieties cane sugar is the sweetest and most soluble.

Sugar is a valuable food, and serves to render other foods more palatable; but, if taken in excess, or to the exclusion of other foods, it may make the consumer unduly fat, interfere with the appetite for foods which are not sweet, and not being wholly absorbed, undergo fermentation, giving rise to acid conditions of the stomach, etc.[2]

168. The *inorganic constituents of food* are water and the chemical salts. Some of the salts are needed in a comparatively large amount for certain parts of the body, as lime for the bones; phosphorus for the bones, muscles, and nervous system; iron for the blood; and alkalies for the liver.

169. Of all substances, a regular supply of *water* is the most essential to the maintenance of life. If deprived of it for eight or ten hours, far greater inconvenience, pain,

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[1] Cane sugar is obtained from sugar cane, beet root, sugar maple, etc. Glucose is combined with cane sugar and fruit sugar, in peaches, pineapples, and strawberries; and with fruit sugar in honey, grapes, cherries, etc., and in raisins and other dried fruit, and is frequently found in the animal fluids. Milk sugar is the saccharine ingredient of milk.

[2] Good candy, not impaired by deleterious coloring matter, or other substances, and eaten *in moderation*, is a serviceable food, especially when the diet is deficient in carbonaceous elements.

and debility is suffered than upon a similar deprivation of solid food. With water, life may be sustained without the aid of other food for several weeks; but, if entirely deprived of it, death is likely to result in a few days. (*a.*)

170. *Water* is present *in all the tissues*, solid and semi-solid, and in *all the fluids*, and, it is estimated, constitutes about 70 per cent of the entire weight of the body.[1] It gives fluidity to the blood and secretions, enabling them to perform their functions of introducing into the body, and discharging from it, substances held by them in solution. The elasticity of bones, cartilages, and muscles, and the flexibility of tendons and other tissues, are largely due to its presence.

The quantity introduced into the body of a healthy man as a drink, and in various foods, in temperate climates, is on an average about four and a half pounds per day.[2] *It is found in every kind of food*, whether solid or fluid, and the amount so taken is not usually appreciated.[3]

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[1] Quantity of water, according to Dalton, in 1000 parts of

Saliva	995	Bile	880	Muscles	750
Perspiration	986	Blood	795	Cartilage	550
Gastric juice	975	Brain	789	Bones	130
Pancreatic juice	900	Ligaments	768	Teeth	100

[2] According to Dr. Dalton, "there is reason to believe that a certain quantity of water also makes its appearance within the body by the liberation of its elements from various organic combinations."

[3] "Number of pounds of water in 100 pounds of

Sugar	5 lbs.	Fat beef	51 lbs.
Rice	13 "	Fat mutton	53 "
Indian meal	14 "	Lean mutton	72 "
Peas, wheat flour, barley meal, oatmeal, butter fats, dried bacon	15 "	Egg, ox liver	74 "
		Potatoes, eels	75 "
		Parsnips	82 "
Bread	37 "	Turnips	91 "
Fat pork	39 "		

"In 100 pints of New milk . . . . 86 lbs.
Skimmed milk and butter milk . . 88 lbs.
Beer and porter . . . . 91 lbs."

— *Health.* Edward Smith, M.D. London.

After performing its part in the various nutritive processes carried on in the body, about 20 per cent is exhaled from the lungs, 30 per cent discharged by the skin, and 50 per cent by the kidneys and intestines.

171. Next to water the most important inorganic constituents of the body and food are sodium chloride, or common salt, calcium phosphate, iron, phosphorus, and sulphur. *Salt* is essential to the life of animals, and is found in their every tissue, with the exception of the enamel of the teeth. It is also a constituent of almost all food, and exists in small quantities in almost every spring, soil, and plant. The quantity taken with food as furnished by nature is generally insufficient for the needs of the body, and hence its use as a condiment. It assists in regulating the processes of endosmosis and exosmosis, and excites the digestive secretions, thus stimulating the appetite. Its value is indicated by the natural craving of the system for it, and by the results of experiments upon the lower animals. Without it, digestion would be imperfect and health could not be long maintained. We are told that the ancient laws of Holland "ordained men to be kept on bread alone, unmixed with salt, as the severest punishment that could be inflicted upon them in their moist climate." Animals will go long distances in search of salt, and if deprived of it, their hides become rough and tangled, their spirits dull, and they finally lose health and strength. In countries where salt is scarce, it is sold at fabulous prices. (*a*.)

172. *Lime* occurs principally as calcium phosphate, and calcium carbonate, the first being most abundant. Lime is an ingredient of every tissue and fluid of the body, but is especially necessary in the bones and teeth, where it affords strength and consistency.

We have already seen that a deficiency of lime salts renders the bones soft, so that they easily bend; hence, during early life, when the tissues are developing, lime salts should be supplied in comparatively large quantities. Of all articles of food, meat, milk, and vegetable grains contain lime in the largest amount.

Of *iron* about one-third of an ounce exists in the body in connection with the coloring matter of the blood, of which fluid it forms about one-thousandth part. It is a constituent of milk and eggs, and is sometimes found in water. Its importance to health becomes appreciated, when, as a medicine, it restores color to the skin and enriches the blood.

Phosphorus and *sulphur*, in the form of phosphates and sulphates, are introduced into the body with food, and enter into the composition of muscles and other tissues.[1]

173. The *vegetable acids*, malic, citric, tartaric, etc., are found in fruits and vegetables, combined with the bases, lime, soda, and potassa, forming salts known as malates, citrates, etc. These salts are indispensable in food, for in the body they are converted into carbonates, and assist in furnishing alkalies to the blood and other fluids.

174. The *quantity of food* needed varies greatly, depending upon age, health, occupation, digestive powers, and other peculiarities, also upon the climate and season, the amount of clothing worn, upon the kind of food used,

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[1] "The element phosphorus seems no less important from a biological point of view than carbon or nitrogen. It is as absolutely essential for the growth of a lowly being like penicillium as for man himself. We find it peculiarly associated with the proteids, apparently in the form of phosphates; but we cannot explain its *rôle*. The element sulphur, again, is only second to phosphorus, and we find it as a constituent of nearly all proteids; but we cannot tell what exactly would happen to the economy if all the sulphur of the food were withdrawn." — *Text Book of Physiology*. FOSTER.

and other circumstances. In infancy, a period of rapid growth and development, a proportionately larger amount of food is needed than at any other period of life.[1]

A healthy, growing child, with the muscular strength and nervous energy of youth, will often eat, if it does not require, as much food as the average man;[2] while old, feeble, and inactive persons require but very little food.

Lewis Conaro, a Venetian, leading a quiet life, subsisted for 48 years on 12 ounces per day of vegetable matter, and 14 ounces of light wine.

During the late siege of Paris, when the inhabitants were inactive, a diet which barely supported life consisted of 10 ounces of bread and 1 ounce of meat daily.

175. Active mental or physical work renders an abundance of substantial food necessary.

Proper work cannot be accomplished on an insufficient or improper diet. It happens sometimes that in prisons, and even charitable institutions, the daily ration is diminished below the physiological standard for the sake of economy. If there is but little activity of mind or body, some diminution may not be attended with actual disease, but if active, healthy children are scantily fed, or convicts in prison are compelled to do hard work on a light labor diet, sickness, great feebleness, and even death result.

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[1] During the first year of life a child should grow from six to eight inches, and should weigh at the end of the year two or three times as much as at birth. In the second year the growth should be only about *half* as much as in the first. In the third year only about a third as much. After the third year the weight and growth are more uniform. To meet these demands it is generally necessary to feed infants every two, three, or four hours.

[2] "In case of in-door operatives, the dietaries of women should be about one-tenth less than those of men. A child at ten years of age will require half as much nutriment as a woman, and at fourteen quite as much as a woman. Young men who have not reached their full growth, but who are doing the same amount of work as adult men, require more food than the latter." — *Handbook of Hygiene and Sanitary Science.* WILSON.

Size alone does not determine the amount of food required. In fact, large and fat people often thrive on a scant diet, especially if there be a great indisposition to muscular exertion, while thin and diminutive persons, particularly hard workers, may eat and digest a very large amount. As people become better supplied with this world's goods, the tendency is to eat too much. A loss of wealth sometimes restores health, by a diminution in the quantity and a change in the quality of the food consumed. Persons in moderate circumstances often learn how to thrive on what is considered by many an insufficient amount of food. The body exposed to a cool, bracing atmosphere, or to extreme cold, demands an increased supply of food.[1] According to Dr. Hayes, the Arctic explorer, the daily ration of the Esquimaux is from twelve to fifteen pounds of meat, about one-third of which is fat.

176. The *digestibility* of food must to a large extent regulate the quantity to be eaten, especially of certain kinds, such as beans, peas, cheese, and rice. A *healthy appetite*, if the individual is able to supply himself with the food he desires, is ordinarily nature's regulator as to quantity, and also quality. Appetite normally asserts itself at regular intervals, or what we call meal-times, and may then be appeased by a moderate quantity of food. But an undue excitation of the muscles and mucous membrane of the stomach, by irregular eating, will produce in time the habit of an irregular secretion of the gastric juice, a consequent variable appetite, or a frequent and gluttonous desire for unnecessary food. The excessive amount of food thus eaten disorders the processes of

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[1] The ravenous appetite noticed amongst the inhabitants of cold climates may be due, in part, to the fact that their food supply is very irregular, so that when supplied with food they eat to excess.

secretion, assimilation, and excretion, and induces disease.[1] As Dr. Beale remarks, "The generally received theory propounded by some popular philosophers, that the more you consume in the way of food the more work will your machinery perform, is a principle which may apply to machines, but not to man."

177. The appetite may be aroused by attention to hygienic measures, such as proper mental and physical exercise, bathing, rest, and the proper selection, cooking, and presentation of food; also, by vegetable bitters, by condiments, etc. It is diminished, on the other hand, by inattention to hygiene, by worry, by opium and other drugs, and by an abuse of alcoholic stimulants.

178. The knowledge of the kind and daily amount of food required by the average individual, among an aggregation of persons whose social and hygienic surroundings are about the same, — as in an army, on shipboard, or in an institution, — affords a criterion upon which to calculate the kind and amount needed by a number of persons. From such estimates Dietaries or Diet Tables are constructed.

The *requisite daily amount of food* for the maintenance of the health of "a person of average stature under exposure to a temperate climate and a moderate amount

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[1] "A voracious appetite is a condition which I suppose may be due to a very irritable state of the nerves of the stomach. . . . The voracious appetite, as we see it existing in children and young people, usually comes from undue encouragement. The greater the desire for food the more food the individual eats, and so he goes on, until he succeeds in consuming several times as much food as his system requires. Thus is thrown upon important organs the task of eliminating a quantity of useless material which ought not to have been taken. . . . A child perhaps is rather thin, and therefore encouraged to stuff, and by degrees the habit of taking enormous quantities of food is acquired, with the not uncommon result to the patient of getting thinner, instead of gaining in weight." — *Slight Ailments.* LIONEL S. BEALE, M.D., F.R.S.

of muscular work" is 23 ounces of dry, solid matter,[1] or 46 ounces of solid food as ordinarily consumed; 50 to 80 ounces of water, in addition to that in the solid food, is also necessary. The solid food thus consumed contains about 300 grains of nitrogen, and 4,800 grains of carbon. (*a.*) A diet, in which the quantity of food and the relative proportions of nitrogen and carbon are much below the above estimates, induces the symptoms of starvation with greater or less rapidity.[2] (*b.*)

179. In the *selection and preparation of food* there are certain points to be observed: the diet should consist of animal, vegetable, and mineral food, in such proportion and condition as will afford nutrition, avoid monotony, and tempt the appetite.

Unquestionably a diversified diet best fulfils the above conditions. Wheat bread, valuable as it is, contains about 25 per cent of carbon, and only 1 per cent of nitrogen. In order therefore to obtain the required amount of nitrogen, if bread alone is eaten, it will be necessary to eat

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[1] "Alimentary substances in a dry state required daily:—

Dry food in ounces avoirdupois.	
Albuminous matter	4.587
Fatty matter	2.964
Carbo-hydrates	14.250
Salts	1.058
	22.859."

— QUAIN'S *Dict. of Med.*

[2] "The first and most important principle established by Chossat is that absolute deprivation of food, and deficiency of food, are physiologically identical in their action on animal life. One acts quicker than the other, but the difference is merely one of duration and degree. Both are equally fatal in the end; and the end in both is regulated by the same law. Death arrives when the body has lost six-tenths of its weight, whether that happens after days, or months, or years." — *Manual of Diet.* CHAMBERS.

In an overcrowded military prison, a diet of one-third of a pound of bacon and one and three-fourths pounds of unbolted meal daily, caused much sickness and very many deaths.

about four pounds a day; in doing which, twice the necessary amount of carbon will be consumed. On the other hand, to obtain sufficient carbon from an exclusive meat diet, a man must eat about six pounds of meat a day, and he would be taking six times as much nitrogen as is necessary.

180. The system craves a *varied diet*, and the living for a length of time on even an abundance of food, if it be unvaried from day to day, will generally result in loss of appetite and in disease. The condition known as scurvy, — in which the blood becomes thin, and settles in spots under the skin, and the gums are spongy and bleed readily, and the individual is debilitated, — was formerly not uncommon on long sea-voyages, especially in the Arctic regions, where the diet consisted largely of bread, tea, and salt meat. At the present time most vessels going on such voyages are supplied with lemons, lime juice, canned meats, fruits, and vegetables.[1] (*a.*) A similar condition is also seen on land in persons who are restricted to a diet in which fresh vegetables and fruit are lacking, or whose food consists mainly of potatoes or bread and tea, with little or no butter, meat, or milk.

181. Soldiers in active service, with restricted and unvarying rations, often have an intense craving for fresh vegetables, such as onions and raw potatoes, which are excellent anti-scorbutics.

When a variety of articles cannot be obtained, varied methods of preparing and cooking the limited supply should be resorted to. "Good cookery means economy; bad cookery means waste."

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[1] Lime juice, by law, is required to be carried on board English ships, and served out to the sailors; hence, English ships are called by American sailors "lime juicers."

182. On the other hand, however, there may be such a thing as *too great a variety*, and this also will destroy the appetite. People living in large hotels, travellers frequently eating in bountifully supplied cars and restaurants, especially if little exercise is taken, often suffer from dyspepsia and disturbed action of the liver and other digestive organs. High livers are apt to resort to alcoholic stimulants and to condiments to excite their jaded appetites. In like manner, the underfed and those living on a very small variety of food often fancy they need the assistance of the cup. In the former case the practice of abstemiousness, and in the latter a more bountiful and varied diet, is really what is required.[1]

183. Articles of food are often robbed of their value, and are sometimes positively harmful, and even poisonous, in consequence of *adulteration*,[2] or of being immature, or stale, or too ripe. Milk diluted with water, or skimmed of a large part of its cream, or that taken from unhealthy cows, is a common evil. "Measly meat," that is, meat containing animalculae, such as trichinae, is occasionally the cause of sickness and death.

184. Vegetables, and meat of coarse texture, which are purchased for economical reasons, are often tough and indigestible. Garden produce, especially corn, cucumbers, celery, and lettuce, when fresh and fully formed, are

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[1] "Coffee houses," "holly tree inns," "diet dispensaries," if properly conducted, can do much to avert a taste for liquor by furnishing suitable food.

[2] Adulteration is very common, and laws to control it are evaded. Frauds in food consist, *first*, in the addition of deleterious substances, such as salt of copper to pickles, and red lead to cayenne pepper. *Second*, in the sale of fraudulent materials, such as cotton-seed oil for salad oil, of flour and a little mustard with turmeric for pure mustard, and of oleomargarine for butter. *Third*, the sale of substances not so fresh and in as good a condition as they are represented to be by the seller.

desirable additions to the table, but may become indigestible, and a source of disease if allowed to become dry and stale. (*a.*) On the other hand, immature fruits and vegetables, such as potatoes, lack the fully formed juices and salts, which are so indispensable to make them serviceable as food. In over-ripe fruit and vegetables the juices and salts have decomposed, giving rise to new combinations which are hurtful.

185. Housekeepers are often hindered, in supplying the table with much of what the various seasons afford, by the *cost* of the articles of food. Yet a careful examination of this question will show that the cost varies greatly in different parts of the same city, and that investigation will soon enable one to furnish a variety of good substantial food at much less cost than is generally thought possible. The instructions afforded by some of the cooking schools should be directed even more than it is to this object. (*a.*)

186. Food of medium quality may be made very serviceable by *proper preparation and cooking*. On the other hand, the very best food may be rendered useless, and also unwholesome, and even dangerous, by improper preparatory treatment. (*a.*) For example, the coarser and tougher portions of meat, and also vegetables of coarse fibre, will be rendered quite tender by prolonged boiling. An important rule in roasting, boiling, or broiling meat, is to produce at the start a rapid coagulation of the albumen on the outer surface of the meat, so as to form a crust that may prevent the juices from escaping. This is done by subjecting the meat at the first to a great heat, after which the cooking should proceed more slowly.[1] In like manner,

[1] On the other hand, the process of soup-making is facilitated if the meat is cut into small pieces and put into cold water, and the temperature slowly raised.

the boiling of potatoes, with at least the larger part of their skins on, prevents the escape of much that is nutritious.

187. *Frying*, as ordinarily conducted, is of all methods of cooking the most objectionable. The slowly heated fat evolves fatty acids which are more or less injurious, and, by penetrating into the particles of the frying food, envelops them in grease. As fats are not digestible in the stomach, it follows that food so fried cannot be properly dissolved by the gastric juice, but becomes an irritant. *To fry properly*, the fat should be boiling hot before the food is put into it, that an outer crust may be formed, which will prevent the fats from penetrating to the interior. And the fat should boil during the entire process of frying.[1]

Food preserved in cans made of so-called tin, but which is in fact a compound of tin and lead, or in cans badly soldered with lead, is liable to become poisonous, especially if such food contain an acid, as is the case with tomatoes.[2]

Food cooked or left standing in brass or copper vessels which are not clean is dangerous to life. Ice boxes, store-rooms, or cellars, which are not clean or are imperfectly connected with drains, are constant sources of poison to milk, water, fats, and other foods which readily absorb poisons from the atmosphere.

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[1] "Scientific frying is really one of the very best modes of cooking, while, on the other hand, the blundering starve-farthing way is the very worst." — *Caterer*.

[2] Much of the detriment arising from eating canned fruits, vegetables, and meat, would be obviated if these goods were preserved in glass jars. Canned fish, especially, should be warmed through before being eaten, by placing the opened can in a basin of hot water. Failure to do this may cause sickness.

Fig. 46.

"No wonder the meat won't keep, the beer turns sour, and the milk disagrees. Open grates in cellars are often untrapped, and, when trapped, the traps are usually ineffective from want of water, or from being broken; and even if sealed by water, they are still an inefficient barrier to sewer gases, which can pass by absorption through water." — *Dangers to Health.* TEALE.

QUESTIONS.

1. What is food in a physiological sense?
2. What are positive and what negative foods?
3. What are the sources of food, and of what use are the coarser ingredients?
4. How is food classified as to its origin, and how many chemical elements must be supplied by it?
5. How are the organic constituents divided?
6. What are the distinguishing features of the nitrogenous constituents?
7. From what sources are they derived in the greatest abundance?
8. What are the principal forms in which they exist in animal and vegetable foods respectively?
9. What peculiar property has fibrin?
10. What are the non-nitrogenous constituents, and what is their value?
11. From whence is fat chiefly obtained?
12. What is to be said of its digestibility, value, and varied use?

13. Where is starch found, and in what different forms?
14. When is starch most digestible, and why?
15. When is fruit most digestible, and why?
16. Why should an over-abundance of starchy foods be avoided?
17. What substances are allied to starch, and what is their nutritive value?
18. What are the distinguishing properties of sugar?
19. What principal varieties of sugar are there? What is their value?
20. Name the principal inorganic constituents of food.
21. To what extent is water found in the body?
22. How is it received into the body, and what proportion is excreted by the lungs and skin?
23. Of what use is salt in food?
24. What purpose does lime serve in the body, and how is it obtained?
25. State the quantity of iron in the body. How mainly received, and its utility.
26. What other substances are found in the blood and tissues?
27. What is to be said of the vegetable acids?
28. What does the necessary quantity of food depend upon?
29. How is this modified by age? By size? By climate and temperature, by the nature of the food and the appetite?
30. What are the effects of too low a diet, and of too much food?
31. What should guide us in forming a dietary?
32. What becomes especially important where there is no variety of diet?
33. What, however, may be the consequence of a too varied diet?
34. What is to be said of the resort to stimulants alike by the over and the under fed?
35. What as to the condition of foods as obtained in our markets?
36. What is the proper mode of frying, and why? and why cannot improperly fried food be digested?
37. What is to be said of the vessels in which food is kept?

ANALYSIS OF CHAPTER NINE.

FOOD.

I. Constituents or Component Principles.

- Organic . . . .
  - Nitrogenous . . . . .
    - How essential?
    - Varieties . . .
      - Of *animal* —
        - Albumen.
        - Fibrin.
        - Casein, etc.
      - Of *vegetable* —
        - Albumen.
        - Gluten.
        - Casein, etc.
  - Non-nitrogenous . .
    - How essential?
    - Varieties . . .
      - Fats and oils.
      - Starches.
      - Sugars, etc.
- Inorganic . .
  - Water.
  - Salts. — Chlorides, phosphates, etc.; lime, etc.
  - Sulphur.
  - Iron.

II. Quantity.

DIETETICS.

1. Selection of food . . . . .
   - Constituents.
   - Variety.
   - Freshness.
   - Maturity, cost, etc.
2. Preparation of food . . . . Cooking, etc.

CHAPTER X.

FOODS. — ALCOHOLIC STIMULANTS.

188. The various articles of food may be classified as animal, vegetable, and mineral. *Animal foods* comprise the flesh of animals, their blood, secretions (milk, eggs, etc.), and also their various organs, which, though not containing so much nitrogen as flesh, are often more serviceable if eaten with proper vegetable food.[1]

Flesh or *meat* consists of muscular, connective, and adipose tissues, and contains albuminoids, water, fat, and salts. On account of its abundant supply of nitrogenous ingredients, its stimulating properties and pleasant taste, meat is usually ranked as a very nutritious[2] food; and is therefore frequently eaten to excess, especially by little

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[1] The organs most commonly used as food are the heart, liver, pancreas, or "stomach bread," thymus gland or "sweet bread," and the stomach or "tripe." Pigs' feet and ox tails are highly esteemed by many. The heart — though composed almost entirely of muscle — is not always easily digested, while tripe is in general readily digested. The latter contains but about 13 per cent of albuminoids and 16 per cent of fat. In fact, most of the internal organs do not contain a large amount of nitrogen, and should be eaten, therefore, with grain food or vegetables comparatively rich in nitrogen. Bones, which are thrown away by many housekeepers because they are of "no use," if well broken up, and submitted to prolonged boiling, will yield fat and gelatine which may form the basis or "stock" for nutritious soups. (*a*.) When meat is roasted, the drippings contain much nutriment, and, if boiled, or submitted to prolonged simmering, as in the making of soup, much of the juice of the meat goes into the broth, leaving the meat quite hard. These drippings and this broth should be eaten with vegetables, rice, barley, etc.

[2] The terms "nutritious" and "wholesome" are too commonly applied by individuals to articles of food which suit *their own* tastes and digestion.

"To assert a thing to be wholesome without a knowledge of the condition of the person for whom it is intended, is like a sailor pronouncing the wind to be fair without knowing to what port the vessel is bound." — VAN SWIETEN.

children, old people, the feeble, and the inactive. (*a.*) It requires to be properly prepared and thoroughly chewed before it can be safely swallowed or readily digested. (*b.*)

189. The various kinds of meat differ as to their *digestibility* and *nutritive value.* Beef, mutton, lamb, poultry, the flesh of many fishes, also venison and other "game," are generally more easily digested than pork, veal, and salted or pickled meats.[1] Different parts of the same animal vary as to flavor and tenderness; but the cheaper portions, though ordinarily tough and indigestible, may, by proper cooking and seasoning, be rendered nutritious and palatable. The age of animals, the kind of feeding, and the care observed in their housing and transportation, influence the flavor and nutritiousness of the meat obtained from them. As a rule, the flesh of young animals is more tender than that of old ones; but meat, especially veal, from very young animals is unwholesome.

190. Pork, owing to the quality and quantity of its fat, and the compactness of its lean meat, is not readily permeated by the digestive secretions during digestion; but if obtained from animals properly fed and cared for, it is serviceable. Salted food, whether meat or fish, in small quantity, will stimulate the appetite, and is useful as an occasional article of diet. Of all varieties of meat, beef is most often used, and is least liable to pall upon the appetite. (*a.*)

191. As to *poultry* and *game*, tenderness and flavor are the most desirable characteristics. Old birds, and old

[1] Hippophagy, or the eating of horse flesh, is advocated by good authorities, especially when beef is hard to obtain. "Such food is a valuable resource in France, where many of the people scarcely ever touch meat, in consequence of the enormous disproportion between the production of cattle and the population of the country."

game animals, are generally tough and indigestible, and their fat is often rank.[1]

192. *Fish* should be eaten oftener than it is, as a substantial food, and not merely as a relish, or simply "for a change." The constituents of the meat of different kinds of fish vary, however, considerably. Salmon and shad contain much fat and nitrogenous matter; flounders and cod-fish a less proportion. The following fish, in the order named, contain the largest amount of albuminoids; viz.: red snapper, white fish, brook trout, salmon, blue fish, shad, eels, mackerel, halibut, haddock, lake trout, and striped bass, and after these the cod and the flounder. (*a.*)

193. All fish are best when "in season," but should be selected with care. The freshness of a fish is determined by the fulness and brightness of the eyeballs, and the vivid color of the gills. The sense of smell cannot always be relied on in selecting fish, since packing in ice to a large extent prevents the escape of odor.[2]

Shell fish, and the flesh from the hind legs of frogs, eaten in season, are valuable edibles; though some of these foods at times prove more or less indigestible, and excite reddening and an almost unbearable itching of the skin, known as "hives" or "nettlerash." (*a.*)

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[1] Experienced poulterers and butchers claim that every variety of fowl and game has its particular season, and at such times the flesh will be found tender and palatable, even in old birds, just as fruit eaten "in season" is far preferable to that which is forced for an early market.

[2] "I ought, perhaps, to refer briefly to the very widespread but unfounded notion that fish is particularly valuable for brain food, because of its large contents of phosphorus; suffice it to say, that there is no evidence as yet (though we hope to have more data before long) to prove that the flesh of fish is especially richer in phosphorus than other meats; and even if it were so, there is no proof that it would be on that account more valuable for brain food. The questions of the nourishment of the brain and the sources of intellectual energy are too abstruse for speedy solution in the present condition of our knowledge." — *Extract from Paper read before the American Fish Culturists' Association by* Prof. W. O. ATWATER *of Wesleyan University*, 1880.

194. Meat partially decomposed is preferred by some; and, though the stomach may by habit become accustomed to such food, yet, in the majority of cases, it either causes indigestion and severe sickness, or deteriorates the system so that it easily succumbs to contagious and infectious diseases. (*a.*) It sometimes happens, notwithstanding the vigilance of health authorities, that unwholesome meat is sold in the shops. Therefore it is important that buyers should know what constitutes good meat. (*b.*)

195. Again, the value of meat as a food is too frequently diminished by the condition in which it is eaten. Overdone meat is more or less insipid and indigestible in proportion to the prolonged action of heat. Meat which is eaten just warmed through, or in a raw state, may prove dangerous to health, from the trichinae or other animalculae it is liable to contain. To destroy these parasites, a heat nearly equal to that of boiling water (212°) is believed by good authorities to be necessary.[1] In fact, meat should be cooked just enough to coagulate its albumen and blood, develop its flavor, and render it tender and agreeable to the sight.

196. *Milk* is justly considered the "model food"; combining, as it does, all necessary food elements in the form most digestible for the majority of persons. It sustains the life of infants at a time when the digestive organs are most sensitive. It should be the principal food of children, and is capable of sustaining the life of adults. Contrary to a popular belief, milk is of decided value in fevers and many other ailments. Persons with whom milk does not agree, or whom it is said to make "bilious," will often be

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[1] The cases of "parasite poisoning" occur in persons who have eaten raw or underdone meat, as in sausages, pork or veal pies, from the inner parts of a roast, etc.

able to digest it if it is taken in small quantities warm and fresh from the animal, or with the addition of one-fifth or one-sixth lime water, or one-half seltzer water.[1] Necessary as good milk is, it is a common experience to receive it deprived of its cream, diluted with water, or otherwise adulterated by dishonest dealers.[2] It is capable of absorbing noxious odors and emanations, and may convey the infection of scarlet and typhoid fevers from infected milk rooms. So susceptible is even the very best milk to change, that a thunder storm, or exposure to heat, or the contact with the smallest particle of sour milk, will render it unfit for use. Great care, therefore, is to be observed in keeping milk. The store rooms, as well as the vessels containing it, should be clean and free from odors.

197. *Buttermilk*, or milk deprived of most of its fat in the process of butter making, is a wholesome drink, pleasant for summer use. It is sometimes prescribed for invalids. *Skim-milk*, or that from which the cream has been in part removed, is more valuable than buttermilk, as it

[1] "Composition of cow's milk:—

Water	87.02 parts.
Casein	4.48 "
Butter	3.13 "
Sugar of milk	4.77 "
Mineral ingredients	0.60 "
	100.00." —DALTON.

The value of milk as a food is not appreciated by many people, though it forms a large part of the diet of certain communities. It is too often regarded merely as a "drink," a "sup," or a "taste," and not as a nutritious article of food. Goat's milk is a good substitute for cow's milk, though not so readily digested. In the early history of many of our large cities, goats and cows were driven from door to door so that the milk might be obtained warm and fresh.

[2] Milk may even *appear* rich (due to its cream or fat, which rises to the surface), and yet be deficient in albumen and salts. It is a sad fact that in large cities, unwholesome milk, known as "swill milk," "skimmed milk," etc., is largely consumed by the children of the poor, to the exclusion of other food, and is responsible for many deaths among them.

contains more of the various ingredients of milk. *Whey*, or milk from which most of the casein has been removed in the process of cheese making, even when slightly sour, is readily digested, and can be made palatable by adding to it a little nutmeg and sugar.[1]

198. *Butter* is a most important food, if fresh and sweet. It consists principally of the fat of milk, with water, and a small quantity of casein and salts. "Oleomargarine," when made from healthy beef fat, is undoubtedly preferable to poor butter, and for cooking purposes it is superior to much of the fat that is used, but it is not so palatable or nutritious as good butter.[2]

199. *Cheese* contains the nitrogenous elements of milk, but not in a very digestible form. It should not be eaten in large quantities by any one; and, for children and persons with weak digestion, it is not suitable, except in minute amount. Very young children should never eat it. New cheese is more digestible. Old cheese, however, in small quantity, is good for an appetizer; but skim-milk cheese is almost pure casein and hard to digest.

200. *Eggs* are, like milk, typical articles of food.[3] They

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[1] In referring to buttermilk, Dr. Chambers says, "it is refreshing and nutritious, and to see it given to pigs, instead of being distributed to the neighbors, makes the philanthropist's heart bleed." "Some think that skim-milk is worth very little, and buttermilk still less, whilst they give whey (if at all) only to the sick. This is a very great mistake, and the poor should get all the buttermilk and skim-milk they can obtain; they may be purchased when new milk could not be afforded." — *Foods.* EDWARD SMITH, M.D.

[2] Recently there has been introduced into the market a substance made from cotton-seed oil, called "cuisine," which can be substituted for lard and cheap butter in cooking.

[3] "Composition of eggs: —

	WHITE OF EGG.	YOLK OF EGG.
Water	80.00	53.78
Albumen and mucus	15.28	12.75
Yellow oil		28.75
Salts	4.72	4.72
	100.00	100.00."— DALTON.

are most digestible when eaten soft boiled, or in omelets, or incorporated with sugar, starch, or flour, as in plain puddings.[1]

201. *Vegetable foods* include the cereals or "bread stuffs," "garden produce," and fruits.

The *cereal grains* most commonly used as food are wheat, barley, oats, corn, rye, and rice. Wheat is rich in nitrogenous matter, salts, and starch, and is generally considered to be among the cereal foods, — like beef among meats, — the foremost in nutritive value. Barley ranks next. Rye, though containing a large amount of nitrogen, is not generally so readily digested as wheat and barley. Oatmeal and corn contain much nitrogen, and more fat than the other cereal grains, and are valuable to persons not troubled with weak digestion. Rice, though easily digested, contains a large amount of starch, and but little nitrogen; hence, to satisfy the appetite, it must be eaten in large quantity if taken alone.

202. Cereals resemble each other, in that each kind consists of a starchy body enclosed in a skin or husk (sometimes of several layers) which, when detached from the kernel, is known as "bran." Immediately beneath this husk is a layer rich in gluten, oil, and salts. The husk is generally woody, fibrous, and indigestible. When removed by the process of milling, the whole grains may be used, or they may be crushed, as in the case of wheaten grits and coarse oatmeal, or ground fine, as wheat flour and maize meal. The finest and whitest wheat flour often contains much starch and but very little gluten. Flour best adapted for family use is that which has a

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[1] Eggs as ordinarily fried are particularly hard to digest. On the contrary, an egg broken into a hot dish (containing a piece of good butter), over a hot fire, rapidly coagulates, and is of easy digestion if eaten while hot.

slight yellowish tinge, is not very fine, and contains sufficient gluten to form a coherent ductile dough when mixed with a little water. Flour made from white wheat is whiter than that from red wheat; but the yellowish tinge in the darker brands of flour somewhat fades out as the flour dries.[1] It will make darker looking bread than pastry flour, but is sweeter and more nutritious.[2]

203. *Bread* is ordinarily made from wheat flour, since other flours do not easily mix for baking; though rye, maize, and oatmeal may be combined in varying proportions with wheat flour for various kinds of bread. Good bread may well be called the "staff of life," the only nutritious element deficient in it being fat.[3] This is commonly supplied by butter or oil.[4] Hot, poorly cooked, or very moist bread is not digested with ease. Leavened bread, *i.e.*, bread "raised," or made light and spongy by means of carbonic acid gas forced through the sponge (as the doughy mass is called), is much more easily digested than unleavened bread, — which is a mixture merely of flour, water, and salt, — such as "pilot biscuit" and "hard tack."

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[1] The old-time custom of squeezing the dry flour in the hand, for the purpose of testing the proportion of gluten as shown by its cohesive qualities, will not hold good with flour made by the "new process"; and even the test of pulling the moist flour between the fingers does not always prove true. In fact, the only absolute proof of good flour seems to be in the cooking, though it is said that flour rich in gluten takes up a great deal of water in proportion to its bulk.

[2] Oatmeal and barley are sometimes not relished, because of a "burnt" taste given in the process of kiln drying, or a musty odor and taste from having been kept in a moist state. "The steam-cooked cereals," being partly cooked, are easily prepared for the table, and, owing to the partial change of starch into dextrine, are quite readily digested. Rye should be selected with care, as diseased or spurred rye, — known as ergot, — may cause severe sickness and even death. Mouldy maize is capable of producing a serious skin disease known as Pellagra, which is said to be quite common in Lombardy.

[3] "Good flour, well baked, yields about 136 lbs. of bread per 100 lbs. of flour." — *Handbook of Hygiene, etc.* WILSON.

[4] Butter therefore is the "golden head" of the "staff."

Leavening is effected by means of a fermentation generated in dough by yeast, or by a batter of flour and water, kept at a temperature of 100° to 110° F., for five or six hours,[1] or by a piece of fermented dough. Carbonic acid gas, forced through dough by machinery, makes what is called "aerated bread." This gas is generated in the making of bread, biscuit, etc., by the proper combination of soda and cream of tartar, or other substances. Unbolted wheat flour makes the brown bread of Europe, and Graham bread.[2] Such bread is wholesome, but contains so much bran that it should be eaten with caution by persons of weak digestion.[3]

204. *Vegetables* are furnished in our best markets in greater or less variety throughout the entire year. Notwithstanding this supply, they are comparatively but little used, or certain kinds are used to the exclusion of others. (*a.*) No vegetable is more useful than the white, or so-called *Irish potato.* It may well be called the king of vegetables, for it agrees with the majority of persons, and can be obtained in every season of the year. And yet, "hardly $2\frac{1}{10}$ of its 25 per cent of solid matters is nitrogenous."[4] Potatoes are deficient also in fat and salts, and should be eaten with butter and salt, pot liquor, meat gravy, or fat meat. They resemble rice in the large amount of starch they contain, and, like rice, must be consumed in considerable quantity if they form the main ingredient of the diet.

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[1] A little salt added to the batter promotes the fermentation, and gives it the name of "salt-raised bread." When milk is used instead of water, it is called "milk-emptyings bread."

[2] Named after Mr. Graham, the founder of so-called "Grahamism."

[3] The brown bread made from flour, in which bran or woody fibre is almost entirely excluded, is readily digested.

[4] Letheby on Food.

Mapother claims that the almost exclusive reliance upon the potato in certain parts of Ireland has depressed the spirit and energy of the inhabitants, and he urges them to raise and use more of other vegetables.[1]

205. *Sweet potatoes*, though not quite so digestible as white, are wholesome. The yam varieties, which are eaten so much in warm countries, are sometimes mixed in corn meal bread. *Beets*, *carrots*, *parsnips*, *onions*, *leeks*, *oyster plant*, *squash*, and other vegetables, are valuable additions to the table.[2] Potatoes, fresh, succulent, and green, or salad vegetables, — such as tomatoes, cabbage, greens, lettuce, celery, corn, and cucumbers, — are excellent preventives of scurvy, as we have already seen; and in the spring their juices and salts are eminently beneficial.[3] (*a.*)

206. *Peas*, *beans*, and *lentils* contain considerable starch and a large amount of albuminoid material. When dried they are not easily digested by persons leading a sedentary life. Yet on account of the ease with which they can be transported and preserved, these foods are valuable wherever large numbers are to be provided for. But, as is the case with some other vegetable foods, they require more thorough cooking and mastication than meat, though there is a popular belief to the contrary.[4] (*a.*)

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[1] Mapother undoubtedly refers to the poorest classes, who cannot obtain sufficient nitrogenous food, — even milk to use with their potatoes, — and who are also depressed by the want of variety in food.

[2] Carrots and some other vegetables are considered by many persons as fit only for cattle; whereas, the fact is, that if the same attention was paid to their preparation and cooking, as is spent upon other foods, they would oftentimes be considered even delicious. The French and Germans excel in this direction.

[3] Such vegetables, together with fruits, are preferable to sulphur and molasses or so-called "spring medicines."

[4] It is said that General Scott, in referring to want of variety in the dietary of many of the soldiers, used to say "that beans had killed more than bullets."

207. *Fruits* are particularly esteemed for their juices, which consist of water, salts, sugar, and vegetable acids. (*a.*) The amount of albuminoid material they contain is very small. Fresh fruits serve to quench the thirst, to supply acids, sugar, etc., to stimulate the appetite for more substantial food, and to assist in its digestion.[1] Grapes, peaches, oranges, strawberries, cherries, blackberries, raspberries, plums, bananas, apples, pears, and apricots, are considered the most digestible.[2]

208. On the other hand, melons and other cold, watery fruits, are likely to interfere with digestion, especially if eaten abundantly at meal times.[3] Fruit is said to be "gold in the morning, silver at noon, and lead at night." Cooked fruits may be eaten with benefit at any meal. Fruits with small seeds should, if taken in large quantity, be eaten with bread, so that the small and numerous seeds may not prove irritant, or lodge in the appendix vermiformis. Dried fruits, raisins, dates, etc., contain much sugar, and must be eaten in smaller quantity than fresh fruits.[4] *Nuts* contain a large amount of nitrogenous and more or less fat material, and should be thoroughly chewed, and eaten in moderation.

209. *Condiments* are substances which sharpen the appetite, give a relish to food, and stimulate the digestive

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[1] "In hot climates these refreshing fruits grow in great abundance, and render a residence in the tropics tolerable. A slice of melon or other fruit is the common gratuity given in addition to the regular charge for any service in hot climates, and forms a contrast to the lump of fat which is its equivalent with the Esquimaux." — *Maintenance of Health.* FOTHERGILL.

[2] Bananas contain nitrogen, and form an important article of food in the countries where they are raised.

[3] Fresh, ripe melons of a good variety are advantageous in fevers, and whenever the system is being weakened by watery discharges.

[4] Dates, used so largely as food in hot countries, are said not to be the saccharine dates we eat as sweetmeats, but are almost entirely farinaceous.

organs. Of these, salt, pepper (especially the red), mustard, vinegar, ginger, and horse-radish are the most important.[1] Pickles, olives, lemon juice, and sauces belong also to this class of accessory foods. An immoderate use of condiments is injurious, for it causes the consumption of more food than the system requires, and perverts the appetite.

Savory herbs, sage, thyme, sweet marjoram, parsley, etc., should be used to make certain foods palatable, and can often be substituted with advantage for more stimulating condiments. (*a.*)

210. *Drinks* may be divided into natural and artificial. The first class includes water, and milk; while the second embraces tea, coffee, cocoa, and alcoholic stimulants. *Water*, as we have seen, is an important constituent of the body and of all kinds of food. (*a.*) It is of the first importance that drinking water should be good. Pure water, chemically speaking, or that consisting only of hydrogen and oxygen, is probably never found in nature, but may be obtained by distillation. It has a flat taste and is not palatable. Rain water, especially that which falls at the end of a shower, is nearly pure, and is more palatable than distilled water on account of the air it contains. In places where the water supply is not abundant, rain water may be used for drinking if carefully collected and filtered; but if allowed to run over dirty roofs, or over decaying leaves and other vegetable growths, it assumes an unpleasant taste and may prove hurtful.

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[1] "Hard work and attendant good appetite require little else than common salt as a condiment, which should be plentifully used. It was said by Plutarch that *hunger* and *salt* were the only sauces known to the ancients; and the very word 'sauce' is derived from the Latin word *salsus*, 'salted.'" — *Health, and How to Promote it.* McSherry.

211. Drinking water is usually obtained as surface water from brooks, rivers, lakes, etc.; "ground water" from shallow wells and springs; and "deep-seated water" from deep wells and springs. Probably the best form of drinking water is good spring water, that is, from rain or snow, which, after filtering through rocks and gravelly soil, gushes forth clear and sparkling into the air. (*a*.) Water from deep wells, fed as they are by underground streams, is much purer than that from shallow wells, which is largely the drainage from the upper or impurer layers of the soil, and has less chance of being thoroughly filtered by percolation through a great depth of soil.[1] Examples of deep wells are the artesian wells, and such wells as that at Garden City, L.I,[2] and that at Prospect Park, Brooklyn, which last supplies with water a large part of Coney Island five miles away.

212. *Stagnant water*, or that containing *any decaying animal or vegetable matter*, is unfit to drink.[3] Sometimes

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[1] Examinations made from time to time of the water from shallow wells, in cities and towns, have shown it to be frequently contaminated by filth from cesspools and other sources. These reservoirs in many instances were but from 25 to 30 feet distant, and sometimes on a higher plane; according to good authorities they should be at least 100 feet away from drinking wells.

[2] Artesian wells vary in depth from one to three or more thousand feet. Such wells are used in abattoirs, breweries, and other large establishments, where larger quantities of water are needed than can be furnished by the ordinary water supply of cities.

[3] Dead animals remaining in running streams may poison the water for a long distance from the source of the trouble. According to Dr. Smart of the U. S. Army, "shallow wells and defective cisterns are often found filled with water possessing many of the characteristics of marsh water, and at such places will be found cases of malaria, though the blame is invariably laid to a swamp or a mill-pond if there happen to be one near. Wherever there is a plenty of pure water, free from decaying organic matter, there is health."—*From Paper read at the American Public Health Association's Annual Meeting*, 1883.

water is a fruitful source of the most serious infectious diseases, such as typhoid fever and cholera, by reason of the disease germs which it contains, and which may be carried long distances in it. The impurities in deep and sluggish streams are more likely to continue than in brooks and other shallow, active streams, whose water is more freely exposed to the purifying influences of the atmosphere; yet the larger streams, on account of the abundance of water they furnish, and the ease with which it can be obtained, are mainly relied upon for the water supply of cities and large towns. Water taken from them for drinking purposes should be obtained from the middle of the stream and somewhat below the surface, as the refuse from factories, drains, etc., which finds its way to a greater or less extent into these rivers and creeks, is most apt to flow along the sides.[1]

213. The *mode of conveying drinking water* from its source of supply is a matter of great importance. Usually wood, lead, or iron pipes are used for this purpose. Rain water, or any water which is deficient in saline ingredients, flowing through lead pipes, will dissolve enough lead to render it poisonous. Saline ingredients in most river, well, and spring waters, by partial decomposition, line the pipes with a crust, and generally prevent this absorption. Sometimes the water, especially if *hot*, will dissolve enough

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[1] "The river Rhine, it is well known,
Doth wash your city of Cologne;
But tell me, nymphs! what power divine
Shall henceforth wash the river Rhine?" — COLERIDGE.

The answer is, — the oxidizing influences of the atmosphere. It has been shown that the farther away from the source of the impurities, the better is the water for drinking purposes. This is true of ordinary organic impurities, but there is reason to believe that the *germs of disease* are not so readily rendered harmless.

lead to become injurious.[1] It is wise to allow both hot and cold water to run a while before using it for drinking or cooking. Hot water acts upon iron pipes and acquires a disagreeable taste. To obviate the risks above referred to, block tin, tin-lined lead pipes, and glass-lined iron pipes are now recommended by sanitary authorities.

214. Ordinary drinking waters usually contain in various proportions such salts as common salt, and sodium, lime and magnesium carbonates, also some air, as well as carbonic acid gas, which last gives a sparkling appearance and an agreeable taste to water. Mineral waters, whether natural or artificial, contain in addition, iron, sulphur, or other mineral ingredients, and are useful as medicine.

Water containing an excess of salts, especially of lime and magnesia, is known as *hard water*. This hardness may be temporary or permanent; if temporary, it is due to calcium and magnesium bi-carbonates, which salts may be precipitated by boiling, thus rendering the water soft, and in the best condition for drinking. Permanently hard water is due to calcium sulphate and magnesium sulphate, which cannot be precipitated by boiling.[2]

Hard water is not suitable for cleansing purposes, as it forms an insoluble compound with the fats of the soap used, which floats as a scum upon the surface of the water.[3]

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[1] Lead pipes should not be used for soda-water fountains, as the carbonated water dissolves lead readily. The presence of lead in water may be detected by adding a few drops of a solution of sulphuret of iron, which, if lead be present, will render the water black, or dark brown, owing to the sulphuret of lead formed.

[2] Hard water may be softened by the addition of wood ashes, or sodium carbonate

[3] It is said that in Glasgow, by the introduction of water from Loch Katrine, the inhabitants saved in one year thousands of dollars in soap, the water used before having been very hard.

215. The *best drinking water* is that which is clean, colorless, and without odor even after boiling, and is soft, and has just enough salt, air, and carbonic acid in it to make it palatable. Water may be clear and sparkling and still be impure and dangerous; especially is this true of well water which has filtered through graveyards or soils polluted by cesspools, barnyards, etc. That dirty looking waters are not necessarily unfit for drinking is shown by the fact that the muddy water of the Mississippi is drunk with impunity by those accustomed to it.

The "green scum" found on ponds and along the edges of some streams consists mainly of lowly-organized plants, algae, etc. In small quantity they are not injurious, but if luxuriant, their growth indicates the presence of organic matter which is hurtful. If they die and decay, they tend to spoil the water in which they are. (*a*.) Water from melting ice is usually purer than that from which the ice was formed, for freezing is a purifying process; but ice from stagnant ponds, or from water which contains much organic matter, is unfit for use. Whenever there is reason to believe that water is unwholesome, it should be examined both microscopically and chemically by competent persons.[1]

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[1] Organic matters in drinking water, in sufficient quantity to be injurious, may sometimes be detected by the following simple means: First, evaporate a saucer full of water by heat, and observe the color of the residue. If it is brown or black, or turns black on further heating, the water is unsafe; Second, "Add a lump of white sugar to a vial of water, and keep it corked for a few days. If it contain much organic matter it will become in that time perceptibly turbid;" Third, "if it has an unpleasant smell when corked in a bottle and kept in a tolerably warm place (say at 70° F.) for three or four days."

Chemists judge of the amount of the animal or more dangerous impurities in water by the relative quantities present of the nitrates, nitrites, chlorides, and of the ammonia salts, — the result of the decomposition of albuminoids. Recently it has been proposed to judge of the wholesomeness of waters by the relative ease with which different specimens support the growth of vegetable organisms introduced into them.

216. Water, by various methods, may be rid of much of its injurious matter. Boiling will precipitate the bi-carbonate of lime and some of the coagulable organic matter, and destroy some of the disease germs. *Aeration* will render stale or confined waters palatable. Allowing them to settle will render some muddy waters fit for drinking. This settling may be facilitated by previously stirring a little alum into the water.[1] Proper *filtration* will partially remove not only suspended but even some dissolved organic impurities. The filtrating substance may be porous earth, sand, charcoal, certain insoluble powders, fine gravel, sponge, etc., either alone or variously combined. Charcoal, oxide of iron, and sand, are the most active. Filters act partly by sifting out solid particles, and partly by an oxidation of the organic substances, by means of the oxygen in the pores of the material used.[2] (*a.*)

217. *Coffee* and *tea* are not positive foods, but in moderate quantities stimulate dormant energies, tend to retard waste, and assist in the digestion of other foods. Hence they are best adapted for use after a hearty meal, but cannot take the place of the positive foods. They are superior at nearly all times to alcoholic stimulants, and are especially valuable in armies, or wherever the food supply is precarious. But they should not be taken in large amounts, nor very strong, for, thus taken, they act ulti-

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[1] In India a kind of nut is used to coagulate the albuminous matters, and precipitate dirt, etc.

[2] "Probably the best filter is one composed of finely-divided silicon and carbon, pressed into a solid cake. This filter, when dry and clean, will remove a large quantity of organic impurity as well as lead from the water passed through it. Prepared for soldiers' use, it was carried by the English soldiers in the late war in Egypt, and found to be of great service. Placed in even the dirtiest water, the fluid was sucked through the filtering mass by means of a rubber tube and mouth piece, and was rendered fit for drinking."

mately as depressants of the nervous system. If relied upon to supply by their stimulus the place of nourishing food, they produce indigestion and nervousness. Tea and coffee are similar in action, though they sometimes affect persons differently. Each contains a volatile oil which gives odor and flavor, an astringent (tannic acid), and an active principle, — theine in tea, and caffeine in coffee.[1]

218. *Chocolate* and *cocoa* contain fatty matter, also albuminous and starchy materials, and a substance similar to theine and caffeine known as *theobromine*. They are not so stimulating as coffee and tea, but are much better as food. As Dr. Edward Smith remarks in his valuable book on "Health," "Perhaps few foods are so nutritious or will satisfy the appetite so well as cocoa and milk, if plenty of cocoa be used, and it is equally good for all ages, classes, and circumstances."[2]

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[1] Recently rations of coffee have been supplied with advantage to the sailors on some of the great ocean steamers in place of their much-esteemed "grog."

An investigation a few years ago, by the Massachusetts State Board of Health, showed that throughout New England much of the ill health was due to the large quantity of tea and coffee drunk, to the exclusion of other foods. Physicians find that much of the dyspepsia, bad feelings, nervous ailments, etc., among women are due to the fact that ladies, in the absence of their husbands, live upon tea and bread rather than do the cooking, and also to the fact that among the poor tea is used because it is considered cheap and nutritious.

Teas are classified as *green* and *black:* the first being the young leaves, steamed, withered, rolled, and dried quickly. Black tea consists of the older leaves which have been slowly dried, and have undergone chemical changes on exposure to air, etc. A smaller amount of green tea is necessary than of black. In preparing tea for a beverage, the object is to retain the odor as well as the other constituents. Lukewarm water will not dissolve the thein. Boiling will drive off the volatile oil and dissolve too much tannin. Boiling water poured upon tea in close vessels will retain its constituents. Among tea merchants and the Chinese the plan is to put tea into a cup, pour boiling water over it, cover the cup with a saucer, and let it stand a while.

[2] The fresher cocoa and chocolate are the better. Cocoa, especially if retained in close packages in close apartments, becomes musty; and, if exposed to the air for a long time, loses its flavor; hence, in some cities, it is freshly prepared every day by dealers. Unlike coffee and tea, there should be no grounds which cannot be eaten.

219. *Alcoholic drinks* comprise: first, malt liquors, ale, beer, porter, and stout; second, wines of various kinds; and third, spirits, or whiskey, rum, gin, and brandy. There are also other powerful stimulants, such as the cordials; and the milder stimulants, such as cider, and beer made from roots.

220. All of the above fluids contain alcohol in varying proportions as the active ingredient.[1] This substance, one of the results of fermentation, acts as a *temporary* stimulant to the body, if taken in small quantities. In larger amount it acts strongly upon the nervous system, deadens sensibility, and induces irregular muscular action, — in other words, intoxicates.

In still larger amount it is a decided *poison*, capable of destroying life in the young, the feeble, the old, and those not accustomed to its use. The tendency of the indulgence in any form of alcoholic drink is, to weaken and at last destroy the control of the moral nature, as well as to undermine the general health. "The evils of alcoholic intemperance are familiar to all, and it is needless to repeat the details of its horrors. The sad story is told every morning in our police courts, and the newspapers are foul with their recitals of desperate deeds. Yet the worst evils of intemperance are those the least known and least noticed. The gradual changes induced in the nervous system, the slow poisoning of the great centers of thought, — the transmission from parent to child, from generation to generation, of nervous tenden-

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[1] Malt liquors contain the smallest portion of alcohol, 10 per cent being about the largest amount found in them. Light wines, such as champagne, contain about 10 per cent; heavier wines, such as sherry and port, 17 to 19 per cent; and wines which have been "brandied" or "fortified," *i.e.*, had spirits added, have as high as 35 per cent. Of spirits, gin has 38 to 39 per cent by volume; whiskey, 45 to 46 per cent; rum, 48½ per cent; and brandy, 50 to 54 per cent.

cies, progressive mental weakness, imbecility, insanity, idiocy, are evils which far outweigh the results of the midnight brawl, the mother's sorrow, and the orphan's tears."

221. *Malt liquors* contain some of the nourishing elements of the barley and wheat from which they are made, and the malt acts as a tonic; but with the excess of alcohol and water imbibed, habitual drinkers of malt liquors are likely to be bloated from the thinning of their blood, and to become logy and stupid.

Light wines, cider, ginger beer, and similar drinks, act merely as temporary stimulants to the circulation, and thus increase temporarily nervous energy. Frequent resort to them induces artificial tastes and appetites, and the desire for the stronger stimulation which heavy wines and spirits afford. *Spirits*, the strongest of the alcoholic stimulants, cannot be used with too much caution. They frequently produce fatty degeneration of the heart and other important organs, cause thickening and contraction of the connective tissue of the liver, kidneys, and brain, and so impair their functional activity.

Notwithstanding the widespread consumption of stimulants thoroughout the world, alcohol is *not necessary for persons in health.* It is a *valuable medicinal agent;* but its abuse even as a medicine should be guarded against. (*a.*)

222. Alcoholic drinks are frequently taken under the impression that they afford warmth. But the increased bodily temperature they arouse is only temporary, and depends mainly upon the stimulating effects of the alcohol upon the circulation. The bodily heat is in the end diminished, so much sometimes that persons relying upon such stimulation for warmth are apt to suffer intensely

when exposed to severe cold.[1] (*a.*) From the fact that these drinks by their stimulating properties prevent temporary waste, they are sometimes spoken of as food, but are inferior to hot cocoa, tea, coffee, or soups, the stimulant effects of which are more permanent, and are not followed, as a rule, by depression, as in the case of the alcoholic stimulants, thereby producing an apparent need of repeated stimulation.[2]

Indeed so great and unnatural a craving is often generated, that men will drink with avidity alcohol in which are decomposing materials or the bitterest substances, such as quinine, or will drain at one gulp the vilest and strongest liquor without an attempt at dilution.

223. *Tobacco* is another substance which is largely used and also abused. Its *temperate* use may not apparently affect adults unpleasantly, and under certain circumstances may even be advised, yet its use by the young is attended with more or less danger, depending upon the age and temperament, and upon the quantity of tobacco used.[3]

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[1] "The fall of temperature, after the use of alcohol, is to be explained by its effect in dilating the capillaries of the skin, thus allowing freer transpiration of watery vapor and radiation of heat, and this supplies a strong argument against the consumption of alcohol by those who are likely to be exposed to a very low atmospheric temperature." — *Human Physiology.* HENRY POWER, F.R.L.S.

[2] Dr. Kane, in his "Arctic Explorations," says, "Coffee in the morning seemed to last the men through a large part of the day, and tea soothed them after a day's labor and exposure. They both operated upon fatigued and overtaxed men like a charm, and their superiority over alcoholic stimulants was very marked."

"Two tablespoonfuls of oatmeal, with one of pease meal, made into a liquid, with milk and boiling water, and flavored according to taste with salt or with sugar, forms a drink worth any number of glasses of ale or other alcoholic fluid." — *Temperance Lesson Book.* DR. B. W. RICHARDSON. London.

[3] Unfortunately a common and reprehensible habit in our cities and large towns, among even very young boys, is that of cigarette smoking. It is a deplorable fact that cigarettes are so cheap and the sale so open that they are easily procured by children in many of the candy and notion stores near to our public and private schools.

The habitual use of tobacco, especially by the young and persons of a nervous temperament, is liable to produce an irritable condition of the heart and brain, to destroy the appetite, decrease the digestive secretions, and seriously impair the health. (*a.*) Even when used in small amount by such persons, the capacity for study and application is lessened by "headache, confusion of intellect, loss of memory, impaired power of attention, lassitude, indisposition to muscular effort, nausea, want of appetite, dyspepsia, palpitation, tremulousness, disturbed sleep, impaired vision, etc." [1]

By some, tobacco has been ranked as a food, but it contains no nourishment. Its action is upon the nervous system and at times, as with overworked and tired soldiers on a march, it may arouse the dormant nervous energies.

224. Other substances besides alcohol and tobacco, which are largely used for their stimulant or narcotic effects, are opium, Indian hemp or hasheesh, coca, and the betel nut. The frequent use of any of them decreases the appetite, and creates a desire for stimulation. *Opium* is the most seductive of them all: "By its soothing and exhilarating influence it gains such a hold on the moral and physical nature that the strongest will is unable to emancipate the victim from its enchantment." It is indispensible as a medicine, but its frequent use as a stimulant, and in cough mixtures, soothing syrups, cordials, carminitives, and other compounds, interferes with the assimilation of food, and enervates the system. The same effects follow the use of chloral, a substance which is too frequently employed without reason, and indiscriminately.

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[1] Extract from a report by a special army medical board, to the Superintendent of the U. S. Naval Academy, Dec. 3, 1875, on the use of tobacco by the cadets.

QUESTIONS.

1. How may foods be classified?
2. What do animal foods comprise? And what are the components of meat?
3. To what is the tendency to excess in the consumption of animal food due?.
4. What meats are least digestible, and why?
5. What is to be said of poultry? Game? Fish?
6. Why should partially decomposed meat be avoided?
7. What are the objects of cooking meat?
8. What is considered the "model" food, and why is it so called?
9. How should milk be protected from impurities?
10. Why are skim-milk, buttermilk, and whey useful?
11. What is said of butter and its substitutes?
12. What is to be said of cheese? Eggs?
13. What do vegetable foods include, and what cereal grains are most used?
14. What is to be said of wheat? Barley? Rye? Oatmeal? Corn? Rice?
15. How may the cereals be prepared for eating, and what is their structure?
16. Which is the best flour for family use?
17. What kinds of flour are used for bread, and how is it raised?
18. Why are potatoes especially commended?
19. Why should other vegetables be used?
20. What is to be said of peas, beans, and lentils?
21. Why are fruits esteemed, when is the best time to eat them, and why should caution be observed when eating small seeded fruits?
22. What are condiments, and how should they be used?
23. How may drinks be divided? What is to be said of water and of its different kinds, and how may it be purified?
24. What benefit is derived from tea? Coffee? Chocolate and cocoa?
25. What is said of the use and abuse of alcoholic drinks; of tobacco and other stimulants and narcotics?

ANALYSIS OF THE TENTH CHAPTER.

FOODS.

- I. ANIMAL . . . . .
  - Flesh, etc. . .
    - Of Quadrupeds.
    - " Poultry.
    - " Game.
    - " Fish.
  - Milk and its products, — Butter, cheese, etc.
  - Eggs.
- II. VEGETABLE . . .
  - Cereals.
  - Garden produce.
  - Fruits.
- III. MINERAL . . . . . Water and salts.
- IV. MISCELLANEOUS
  - Condiments.
  - Drinks . . .
    - Natural
      - Water
        - Ordinary.
        - Mineral.
      - Milk.
    - Artificial
      - Coffee.
      - Tea.
      - Chocolate, etc.

ALCOHOLIC AND OTHER STIMULANTS.

Fig. 47.

Front view of the organs of circulation. — Veins, black; arteries, with transverse lines. Parts on the left side of figure are removed to show some of the deep vessels, while the right side shows superficial vessels.

CHAPTER XI.

THE CIRCULATION.—BLOOD.—LYMPH.

225. The blood, as we have seen, is the principal form which the nutritive constituents of food take after digestion. It flows as pure blood in one set of currents, from the heart to every cell and tissue for their nourishment, and returns in another set of currents to the heart laden with waste products, which are expelled from the body through the lungs and other excretory organs. This flow of the blood to and from the various parts of the body is *the circulation*, and the organs through which it is propelled are the *organs of circulation.* These organs are the heart and the blood-vessels, the latter consisting of the arteries, capillaries, and veins.

226. The *heart* is a hollow, muscular, pear-shaped organ, about the size of the clenched fist. It is situated obliquely in the thoracic cavity, between the two lungs, chiefly on the left side of the body. Its lower pointed end, or apex, strikes against the walls of the thorax, between the fifth and sixth ribs, a little to the left of the breast bone. At this point we can best feel the impulse of the organ.[1] The broadened upper end, called the base, is about on a level with the middle of the breast bone, near its junction with the cartilages of the third ribs. Owing

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[1] The place and extent of the heart's impulse vary a little with the position of the body, and the motions of breathing. The length of the heart is about five inches; its weight in men is about 10 or 12 ounces, in women 8 or 10.

to its surroundings this end of the heart has comparatively little motion. A portion of the right and lower border of the heart rests upon the diaphragm, and is upon the right side of the "median line" of the body.[1] The left border is entirely upon the left of this line. (Fig. 47.)

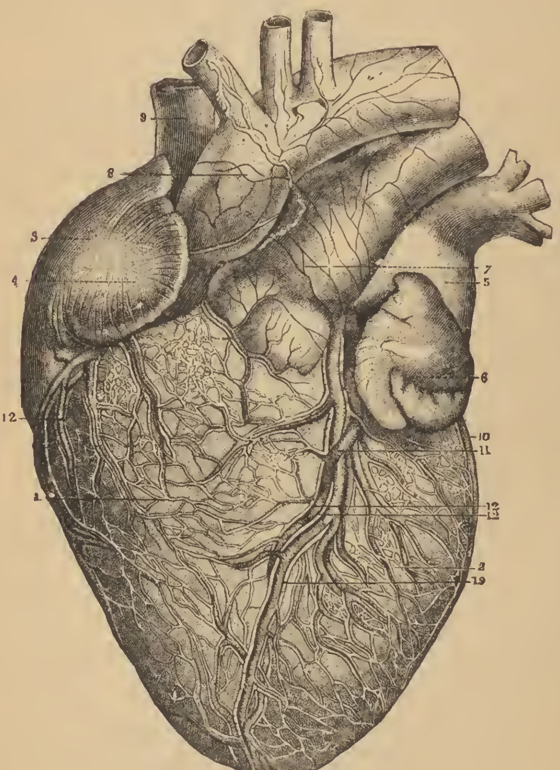

Fig. 48.

Heart, front view. — 1, right ventricle; 2, left ventricle; 3 and 4, right auricle; 5 and 6, left auricle; 7, pulmonary artery; 8, the aorta; 9, superior vena cava; 10 and 11, front coronary artery and vein which in part control the blood-supply of the substance of the heart; 12, lymphatic vessels.

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[1] "A vertical line supposed to divide a body longitudinally into two equal parts, the one right, the other left."

227. The whole organ, with about two inches of the great blood-vessels which arise from it, is enveloped in a fibrous sac known as the *pericardium*.[1] This sac is lined with a smooth, glistening membrane, which secretes a lubricating fluid called *serum*, thus permitting the heart to move freely and without friction. The interior of the

Fig. 49.

Representing the cavities of the heart, and the blood-vessels opening into and out of them. The ventricles are separated in the cut to show the commencement of the aorta. The arrows show the direction of the blood-currents.

heart is also lined with a smooth, serous membrane, called the *endocardium*,[2] which is similar to and continuous with the lining membrane of the blood-vessels.

228. The heart is divided by muscular walls into four compartments or cavities, the two upper ones called

[1] Derived from the Greek, and signifies "around the heart."

[2] Derived from the Greek, and signifies "within the heart."

auricles,[1] and the two lower, ventricles.[2] The first two have veins which open into them, the last have arteries which arise from them. The auricles receive the blood coming into them through the veins, and when full simultaneously contract and force it into their respective ventricles, through openings (one between each auricle and ventricle), which are known as the *auriculo-ventricular openings.* The ventricles then simultaneously contract and expel the blood into the arteries. (Fig. 49.)

The *openings* between the auricles and ventricles, and those between the ventricles and the arteries which connect with them, are guarded by little doors or valves composed of delicate but strong fibrous tissue. These open to allow the blood to pass onward in its natural course, and then close, thus preventing the blood from flowing back, *i.e.*, regurgitating.[3]

The cavities upon the right side of the heart are called, respectively, the right auricle and right ventricle, and those upon the left side, the left auricle and left ventricle.[4] The cavities of the left side of the heart are respectively smaller than those of the right, but their walls are stronger. Especially is this true of the left ventricle, whose function it is to send blood through the entire body. (Fig. 50.)

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[1] "Little ears" (Latin), so called, it is said, from their resemblance to a dog's ears.

[2] Literally, the diminutive of stomach. The appellation is old, and is used by Cicero.

[3] The valves between the auricles and ventricles are operated by slender but powerful muscles within the ventricles. The tendons of these muscles attached to the valves are known as the "chordae tendinae," or tendinous cords. (Fig. 50.) The valves between the left auricle and ventricle are known as the "mitral," from a supposed resemblance, when they are open, to a mitre. Between the right auricle and ventricle are the "tricuspid" valves, *i.e.*, having three points. Between the ventricles and the arteries are the "semilunar" valves, so called from their shape.

[4] Sometimes the heart is considered as a double organ, the right side, transmitting venous blood, is spoken of as the right heart, and the left side, transmitting arterial blood, as the left heart.

229. The *movements of the blood* will probably be best understood if we follow it from point to point in its circuit.

In the first place the venous or impure blood, collected by the smaller veins from the various parts of the body, is poured into two great veins which open into the *right auricle.*[1] When the auricle is dilated and filled to its normal limit, its walls contract and expel the blood through

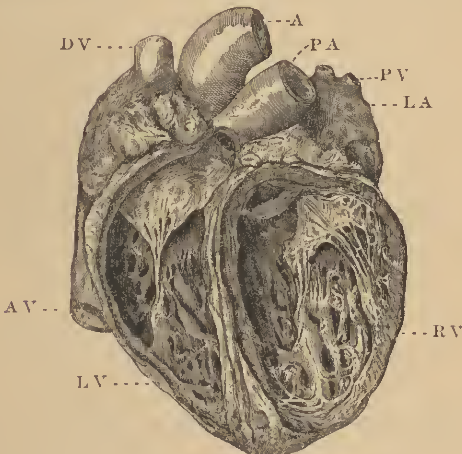

Fig. 50.

The heart and some of its vessels; the ventricles are laid open to show their structure. — A, aorta; P A, pulmonary artery; P V, pulmonary veins of left auricle; L A, left auricle; D V, descending vein, or superior vena cava; A V, ascending vein, or inferior vena cava; L V, left ventricle; R V, right ventricle. The relative thickness of the walls of the ventricles are shown, also the muscle columns and their tendons, together with the curtain-like valves.

the right ventricular opening into the *right ventricle.* The ventricle thus dilated and filled, contracts, and expels its contents through the *pulmonary artery* into the *lungs*, where the blood is thoroughly distributed by numerous "capillary" or hair-like blood-vessels among the air cells, and is purified by exchanging its waste products for the

[1] These veins are called "the superior and inferior venae cavae."

oxygen of the air. From the lungs it is carried as *pure blood* by four veins,[1] known as the *pulmonary veins*, into the *left auricle.* When this auricle is normally dilated and filled, the blood is forced through the left ventricular opening into the *left ventricle.* This ventricle, when dilated and filled, contracts and sends the blood into the *aorta*,[2] the largest artery in the body, and through its dividing and subdividing branches to the capillaries for the nourishment of the tissues. Having parted with much of its life-giving principles, and acquired the results of decay and disintegration in the tissues, the blood requires to be re-purified, and commences at the extremities or sources of the venous system its return to the lungs. Passing successively through the enlarging veins, as though it were a river system, with its springs, brooks, and rivulets, or like the rootlets enlarging into the roots of a tree, it finally reaches the right auricle.

230. The *alternate contractions and relaxations of the auricles and ventricles* cause the heart to roll somewhat, and to elongate, pushing its apex against the chest wall.[3] These movements constitute the pulsations, or "throbbing" of the heart. They are so constant that the organ seems never to have rest, but the alternate periods of relaxation, short as they are, afford in the aggregate very considerable rest to the busy muscles of the heart.

231. The contraction of these muscles, those of the ventricles especially, and the closure of the valves of the heart, give rise to what are known as heart sounds, which can be heard by placing one's ear over the heart of

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[1] Two from each lung.

[2] Sometimes called "the great systemic artery," as it distributes blood to a large part of the system.

[3] These contractions and dilatations are technically designated as "systole" and "diastole."

another, and in contact with the chest, or by means of an instrument called the stethoscope. These sounds are termed the first and second sounds, and changes in their rhythm, intensity, or pitch are indications to the physician of the character of any disturbance or disease in the heart.

232. The *pulsations of the heart* are involuntary. Therefore, influences which operate upon the nervous system operate also upon the heart.[1] Its movements are decreased in frequency by sorrow, depression of spirits, etc., and quickened by mental excitement, joy, anger, etc.; hence the expressions, "one can hear his heart beat," or "his heart is in his throat," or "it beats like a trip-hammer." The temperature of the surrounding atmosphere, the quantity of food, the age, sex, muscular activity, and the position of the individual, also affect the rapidity of the heart's action. At birth the number of beats is normally about 140 per minute, at the end of the first year 120, at the end of the second year 110; during middle life it varies from 70 to 80, being about 10 more in women than men, and in old age is about 60.[2]

The normal frequency of the heart's action varies with the temperament, family tendency, and the individual's mode of living. Of Napoleon I. and the Duke of Wellington it is said, the pulsations were but 40 per minute.

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[1] The action of the heart is controlled in health by two sets of nerves, and so regulated that the exact quantity of blood required at any time is received into and sent out of the organ. The first set (called pneumogastrics), "act as the reins act on a horse in the hands of a skilful driver," while the second (called sympathetic) accelerate the action of the heart.

[2] The pulsations are increased by heat and diminished by cold. In babies they are readily increased or diminished by apparently slight causes. Thus, after crying, the pulse (as the pulsation of the arteries is called), rises 10 to 20 beats, and is lowered the same amount during sleep. After a meal the pulse of an adult has from 5 to 10 beats more per minute than before; 5 beats more when sitting than when lying down, and 10 beats more when standing than when sitting, and 10 to 50 or more beats when in motion than when still.

In some persons, especially those with excitable, nervous temperaments, they number 90 or even more. Very rapid action tends to exhaust the heart; yet the vitality of the organ is remarkable. In warm-blooded animals and in man it is the last organ to cease giving signs of life, and even when it has ceased to beat, electricity has again aroused its action and restored life.[1] In cold-blooded animals, such as the frog and snake, whose heart-action is comparatively slow, the heart will continue to throb after the animal has been beheaded, and even after the heart itself has been removed from the body.

233. *The arteries*[2] are a series of cylindrical, firm, but elastic canals, which commence with the aorta, and by divisions and subdivisions convey the blood to all the vascular parts of the body. The larger arteries are composed of three coats: first, a smooth, delicate, and slightly elastic inner wall, similar to, and continuous with, the endocardium, and the lining of the veins and the capillaries; next, a middle coat composed of elastic and muscular tissue; and lastly, a very strong outer coat, composed of fibrous and elastic tissue with some muscular fibres.[3] As

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[1] The ancients regarded various organs of the body as seats of the emotions. The spleen was the seat of anger and melancholy, hence the term splenetic; while the heart was the seat of joy, love, harmony, and the like. The words, "courage," "cordiality," "heart-felt," "hearty," "heartiness," etc., have their derivation in this idea.

[2] So named from two Greek words meaning "receptacle of air," because the ancients believed that these blood-vessels contained air only, — probably because they generally found them empty in the dead body. Arteries do not collapse when cut as veins do. After death their contents are for the most part emptied into the veins and capillaries. A firm tube of rubber (whose walls keep the canal open, even when the tube is cut across), will give a fair idea of what an artery is; while a tube, with thin, flexible walls, represents a vein.

[3] The elasticity of the larger arteries will be best appreciated in the aorta of an ox or sheep. Like a piece of india-rubber, it yields when stretched, and immediately thereafter recovers itself. The walls of the arteries are nourished by blood conveyed to them by little arteries called *vasa vasorum*. Corresponding vessels also supply the heart.

the arteries become smaller the external coat disappears; hence the very small arteries (arterioles) have but two coats. In the capillaries (which are continuous with the smaller arteries as well as with the commencing rootlets of the veins) the middle coat also disappears, and the thin, delicate, circular wall that remains is well adapted for the transudation of gases and fluids.

Fig. 51.
A portion of an artery. Enveloping it are lymphatics and lymphatic glands.

234. The *smoothness of the lining wall* prevents friction. The *elasticity* of the arteries permits them to yield without danger of bursting, as the blood is thrown into them with each stroke of the heart, and also enables them to accommodate themselves to the various movements of the body. Their *contractility* affords them the power of adapting themselves to the variable quantities of blood which they contain, and which must be supplied to the tissues as required. As the blood is sent into the large arteries from the heart, the flow is intermittent. The calibre of the arteries as they divide and sub-divide becomes smaller and smaller, but in the aggregate that calibre is greatly increased, and, owing to this and to their elasticity and contractility, as the blood is propelled onwards, the pulsations in the arteries are less intermittent as the arteries become smaller, and finally, in the capillaries, the blood current is uniform and constant, but slow.[1] It thus

[1] The motion of the blood in the arteries may be illustrated by connecting a syringe, representing the left ventricle, with a large rubber tube, representing the aorta, which is connected with various tubes of gradually decreasing size, representing the subdividing arteries and the capillaries. The water is injected into the large tube in an intermittent and forcible current, which abates in the smaller tubes and becomes continuous in the smallest.

becomes well adapted to furnish to each cell its appropriate nourishment, and to abstract from each its waste products.[1]

235. The pulsations of the aorta and its branches constitute the *pulse* or wave in the arteries. This is usually felt at the wrist, but may be felt over any artery which is located near the surface, as in the arteries of the upper lip, the chin, temples, elbows, and inner side of the ankles. To determine the character of the pulse more accurately than by the sense of touch alone, an ingenious registering instrument called the sphygmograph may be attached to the forearm, and by means of a lever lightly resting on the pulse, there will be registered with a pencil

Fig. 52.

Portions of four traces taken by the sphygmograph in different conditions of the pulse.

on prepared paper the character of the pulsations. The character of the pulse is a fair indication of the action and strength of the heart, and is modified or altered by the same means that affect the action of the heart.

236. The *capillaries* permeate the vascular organs in meshes of network variously arranged, and bring the blood into close contact with the tissues.[2] In reference to their function, Dalton says, "The nutritious ingredients of the blood transude through their walls, and are appropriated by the tissues beyond. In the glandular organs they supply the substance requisite for secretion; in the villi of the intestine they take up the elements of

[1] It is estimated that the blood flows 360 times faster in the aorta than in the capillaries.

[2] Capillaries are generally about $\frac{1}{3000}$ of an inch in diameter.

the digested food; in the lungs they absorb oxygen and exhale carbonic acid; in the kidneys they discharge the products of destructive assimilation collected from other parts. The capillary circulation thus furnishes directly or indirectly the materials for the growth and renovation of

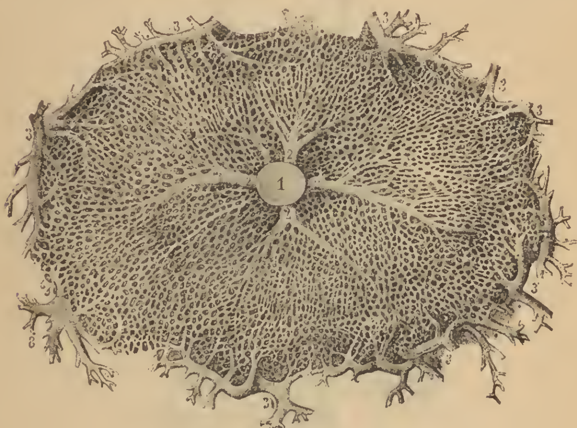

Fig. 53.

Injected cross-section of a lobule of the liver, showing the *capillary* network between the portal and hepatic veins. — 1, section of *intra*-lobular vein; 2, its branches collecting blood from the capillaries; 3, *inter*-lobular branches of the portal vein connecting with the capillary network, and supplying the lobule with blood for its nourishment. — Magnified 60 diameters.

the entire body." This circulation is ordinarily studied in a tissue which is transparent and vascular, such as the web of a frog's foot, or of a bat's wing, and is an exceedingly beautiful and interesting sight.[1] Tissues such as

[1] "We see the great arterial rivers, in which the blood flows with wonderful rapidity, branching and subdividing until the circulating fluid is brought to the network of fine capillaries, where the corpuscles dart along one by one. The blood is then collected by the veins and carried in great currents to the heart. This exhibition to the student of Nature is of inexpressible grandeur; and our admiration is not diminished when we come to study the phenomena in detail. . . . It can be seen how the arterioles regulate the supply of blood to the tissues; how the blood distributes itself by the capillaries; and finally, having performed its office, how it is collected and carried off by the veins." — *Text-book of Physiology.* FLINT.

cartilage, nails, and hair, which have no blood-vessels, are nourished by imbibition.[1]

Fig. 54.

A diagram of the capillary circulation, with arteries in white, veins in black.— T, trachea, arrows representing incoming and outgoing air; D, the diaphragm; A, artery (the aorta); V, vein; 1, capillary circulation of head; 2, vessels of upper extremities; 3, capillaries of the lungs; 4, of the stomach; 5, of the liver; 6, of the spleen; 7, of the pancreas; 8, of a portion of small intestine; 9, of the kidneys; 10, vessels of lower extremities.

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[1] That is, "drinking in," or "absorption."

237. The capillaries having very thin and somewhat elastic walls, readily vary in size, at different times, in response to any exciting cause. They are largest, when a part to which they are distributed is functionally active. Emotion, and exposure to warmth, dilate the small arteries by relaxing their muscular fibres; and more blood at such times fills the capillaries in connection with them, so that the parts to which they are distributed "blush," or become ruddy. On the other hand, pallor is produced by continued cold, anger, fear, etc., which cause the muscles to contract, and the amount of blood in the small arteries and capillaries to be diminished.[1] So numerous are the capillaries that their entire capacity is said to be "from five hundred to eight hundred times that of the arteries." Their extensive distribution may be appreciated when we consider that the slightest cut upon any part of the skin or mucous membrane, which is sufficient to induce bleeding, must cut across many capillaries. They are most numerous wherever the nutritive processes are most active, as in the lungs and glands, and in the mucous membrane of the small intestine, and, during the functional activity of these parts, may be said to bathe them in blood.

238. After the blood has parted with nutriment to the tissues, and absorbed waste products from them, it passes on from the capillaries into larger channels called small veins or veinlets, and then into still larger ones known as veins.[2]

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[1] Blood carried to a part for a length of time, in larger quantity than is necessary for its nourishment, is liable to cause inflammation and even death of the part. When the supply of blood is for a lengthened period much smaller than is demanded, failure in nutrition and even death of the part may result; or if a part has been long contracted, as by frost-bite, and blood is too suddenly brought into it, as by heat, inflammation and death of the part may ensue.

[2] Generally, in the case of large blood-vessels, arteries and veins (and sometimes nerves) accompany each other in one common sheath.

Other waste products not so taken up are carried into the blood by another set of vessels, called the lymphatics, to be hereafter described.

Veins, like arteries, are composed of three coats, but they contain a smaller quantity of muscular and elastic fibres, and a larger proportion of firm connective tissue. They are consequently less elastic and contractile, more flaccid and compressible, but "have equal if not superior capacity for resistance to pressure." They are furthermore distinguished in the limbs and external parts of the head and neck, by being provided with valves so arranged that their closure prevents a backward flow of blood. The position of these valves may be seen in the little prominences that result in the course of the superficial veins if we tie a cord around the wrist or arm.

Fig. 55.
A portion of a vein, with its branches laid open, showing the valves.

239. The *capacity* of the venous system is greater than that of the arterial, owing to its numerous intercommunications. If a blockage occurs in a vein, the blood current can be more readily diverted therefore into one or more branches than is the case with the arteries, but the encircling of an entire limb with a tight band would obstruct the circulation in all the vessels of that region, and induce swelling below the band.

240. The *force and rapidity of the circulation* are very great, but differ widely in the various sets of vessels and in the different organs, whether at rest or during functional activity; but the time required for the passage of the blood from the heart to the vascular tissues and back is

said by Dalton to be "not far from twenty seconds."[1] The flow of blood from the heart into the arteries, and through the capillaries, is effected by the powerful contractions of the heart aided by the contractility and elasticity of the arteries, and in the case of the capillaries, also by the elasticity of the surrounding tissues. So great is the force exerted, that if an artery be cut across, the blood spirts to a distance of several feet.

In health, both arteries and veins readily withstand the force of the circulation, but, when weakened by age, injury, or disease, they may burst under unusual exertion, such as fast walking or running, the lifting of heavy weights, or even by a sudden change of position, as in the quick rising from a recumbent posture. If the vessels of the brain give way, paralysis or death may occur from the pressure of the escaped blood upon the brain. This condition is known as apoplexy. So rapid is the circulation that, on looking at the flow of blood in the web of a frog's foot for the first time, it is difficult even to *see* the blood globules.

241. The flow of blood through *the veins* is more rapid than that through the capillaries, but considerably slower than the arterial current. It is effected by the pressure from the capillary circulation, by the contraction of the voluntary muscles through which the veins pass, and by the act of inspiration, whereby the chest is expanded. This expansion not only tends to draw air into the lungs, but also blood from the veins.[2]

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[1] Dalton estimates that the average rapidity of an arterial current is 12 inches per second, of a venous current 8 inches per second, and the rate through the capillaries is rather less than $\frac{1}{25}$ of an inch per second.

[2] If a vein, especially in the lower part of the neck, be wounded, and considerable air enters the blood, death is likely to result. "The air finds its way to the right ventricle, is mixed with the blood in the form of minute bubbles, and is carried into the pulmonary artery; once in this vessel it is impossible for it to pass through the capillaries of the lungs, and death by suffocation is the inevitable result." — FLINT.

242. *The blood* is eminently the "vital fluid," for it is that constituent of the body which either directly or indirectly affords nourishment and life to all the other constituents, whether solid or fluid. If from any cause much blood is lost, great weakness follows, and if the flow is not checked, death results.[1] On the other hand, if fresh blood from a living person or animal be injected into the veins of an individual much prostrated, or even apparently dead, especially if his condition be the result of loss of blood, he often may be revived. This operation is known as the *transfusion of blood*.[2]

243. To the eye the blood seems to be merely a homogeneous red, scarlet, or dark-blue liquid, according as it is drawn from the capillaries, arteries, or veins. It has a salty taste, and a very small quantity of it is capable of staining a large amount of water. As shown by a microscopic examination, it consists of two portions, the *liquor sanguinis* or *plasma*, and the *globules*. The first is an alkaline, transparent, and nearly colorless fluid, in which the blood globules, corpuscles, cells, or disks (as they are variously called), swim. It is composed of water and

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[1] From 1545 to 1586 several persons described portions of the circulatory apparatus, and their function. In 1602 Harvey began his investigations upon living animals, and in 1616 discovered the circulation of the blood. His description of the movements of the heart are forcible, clear, and accurate. Of the heart, he says "by an admirable adjustment all the internal surfaces are drawn together, as if with cords, and so is the charge of blood expelled with force." Like other investigators in the same field, Harvey was subjected to much persecution.

[2] The operation originated in the 17th century, and much was expected from its use; some believing that old people could be rejuvenated by using the blood of the young; but, after a number of deaths had resulted, it fell into disrepute. The operation has been revived within the last few years, and, owing to improved surgical appliances, and to a better knowledge of the subject, excellent results have been obtained; three or four ounces only of blood have been found to be sufficient at any one time. Warm milk of cows has been successfully used instead of blood.

fatty matters, and of albuminous matters and salts in solution, with some crystallizable substances of organic origin, and forms "about 60 per cent by volume of the entire mass" of the blood.[1]

244. *Blood globules* are of two kinds, the red and the white. The red are smaller than the white ($\frac{1}{3600}$ of an inch in diameter), and much more numerous, there being about 300 to every white corpuscle. So numerous are they, that in every direction, in the thinest film of blood under the microscope, they touch or even overlap each

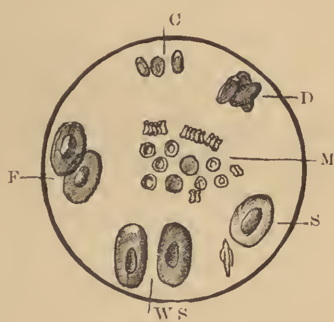

Fig. 56.
Blood globules. — M, of man; F, of the frog; W S, of the water salamander; S, of a shark; D, of the dove; C, of the camel.

other, and it is evident that the red color is due to the globules *en masse*, for, if viewed separately by transmitted light, they are of a light amber color. It has been estimated that there are about five million red corpuscles in a very small drop (a cubic millimetre) of blood. In form they are circular, with flattened sides, and under the microscope are seen to arrange themselves

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[1] The albuminous matters are albumen, paraglobuline, and fibrinogen. "The salts are principally sodium and potassium chlorides, phosphates, and sulphates, together with lime and magnesium phosphates."

in rows, adhering together side by side like a roll of coins. They are of nearly fluid consistency and very elastic, and are easily bent or distorted, to enable them to pass through the smallest blood-vessels. Their most important ingredient is *hemoglobine*.[1] This substance has a strong affinity for oxygen,[2] and unites with it; but the tissues which have a stronger affinity absorb a large part of the oxygen in combination with the coloring matter, and replace it with carbonic acid. It is on account, therefore, of the life-giving oxygen thus carried by the red globules, that they are sometimes spoken of as "little boats laden with precious freight," which are in health dispatched at the right time, to the right place, in the right quantity.

The red globules of the blood of all vertebrate animals contain a coloring matter similar to, if not identical with, that of man, but differ from the globules of human blood as to form, size, and structure.[3] The detection of this difference is sometimes of importance in courts of law in the decision of questions relating to the stains upon murderous weapons, or upon garments, floors, etc.

245. The *white globules* are supposed to change ultimately into red ones. They are larger than the latter (about $\frac{1}{2500}$ of an inch in diameter), have a spherical form, and adhere more readily than do the red globules to surfaces

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1 "The ultimate elements of hemoglobine are carbon, nitrogen, oxygen, sulphur, and iron; the last of these probably being the cause of the red color." — Quain's *Dict. of Medicine*.

2 This gas chiefly finds its way into the blood through the air breathed in by the lungs.

3 In the warm-blooded quadrupeds the structure is the same as in man. The globules have the same disk-like shape, except in the camel family, where the disks are oval. The smallest globules are those of the Java musk deer; the largest, those of the elephant; though their size does not always correspond with that of the animal. In birds, reptiles, and fishes, with but few exceptions, they are oval and have a nucleus. The coloring matter of blood in suspected stains, is frequently ascertained by a spectroscopic examination.

with which they may come in contact.[1] Characteristic of the white globules are what is known as the "amoeboid movements," so named from their resemblance to those of the *Amoeba*, an animalcule living in fresh-water ponds or ditches. These movements consist in the alternate protrusion and retraction of various portions of the globules. By this mechanism the white globules move from place to place when the blood current is considerably slackened, and also "migrate," *i.e.*, escape from the capillaries into the surrounding tissues. Powers says of this "migration" or *diapedesis*, as it is technically called, "under certain circumstances, both white and red corpuscles may escape from the vessels, and pass or wander into the adjoining lymphatics. The escape of the white corpuscles appears to occur normally, whilst the escape of the red only occurs when the pressure of the blood against the walls of the capillaries is much increased, or when there is retardation of the blood current, as in inflammation. In the case of the white corpuscles, the attraction between the corpuscle and the capillary wall seems to be increased, the corpuscle begins to bore its way through the wall, assumes an hour-glass form, part being within and part without the lumen of the vessel, and it finally escapes altogether into the adjoining tissues." How far the nutritive processes are influenced by the migration of blood corpuscles is not definitely known.[2]

246. Blood exposed to atmospheric air *coagulates* or clots spontaneously. This property is peculiar to blood. If it were not for this coagulation we should be liable to

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[1] The term *leucocytes* is applied sometimes to the white corpuscles. These corpuscles are not peculiar to blood, but are found in lymph, chyle, and other fluids.

[2] Diapedesis was first described about 1846, but has been fully studied only within the last few years.

bleed to death from even a slight cut.[1] In most of the warm-blooded animals coagulation is more prompt and thorough than in man, so that there may be extensive injury to blood-vessels without fatal results to the helpless animals. But man is able, by pressure for a time upon a bleeding vessel, or by tying the two cut ends (*i.e.*, ligaturing) to cause the coagulation, and so lessen the danger from extensive hemorrhage. Seldom does the blood clot in the body, unless the circulation is impeded or arrested, and the inner coat of a vessel is roughened by disease, or otherwise injured. A clot formed in a vessel may interrupt the blood supply to a part of the body, and cause the death of that part, or it may be sent in the blood current to the brain, and cause paralysis of a portion of the body, or death of the entire body. A "bruise-spot" is the discoloration produced by blood escaping from injured capillaries, and its coagulation on or under the skin. The rapidity with which it naturally disappears depends upon the severity of the injury, the relative thickness of the skin, the vascularity of the part injured, and upon the health of the individual. When blood is poor and thin, as in scurvy and other blood diseases, it flows readily from wounds, or from the impoverished tissues, producing dangerous hemorrhages and many "bruised spots." The drawing of a tooth, or a pin's scratch in such persons, is liable to result in severe bleeding.

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[1] The clotting of blood may be studied in animal's blood contained in a deep glass dish. The upper portion begins to harden first, and after a time the whole mass is semi-solid. Later on the clot forms and lies in the centre of a light yellow fluid. This firm clot contains globules, fibrin, and most of the coloring matter of the blood, while the fluid known as "serum" contains water, salts, and a little coloring matter. Fibrin formed from the fibrinogen of the blood may be seen in the fibrous filaments remaining after thoroughly washing a clot of blood, or in the fine threads which cling to a bundle of twigs, with which fresh blood has been thoroughly beaten for a time. Such blood remains uncoagulable, and is said to be defibrinated.

247. The entire *quantity of blood* of an individual is about ten per cent of his bodily weight. Of this quantity about one-fourth is distributed to the heart, lungs, large arteries, and veins, one-fourth to the liver, one-fourth to the muscles, and the remaining fourth to the remaining organs and tissues. The brain receives one-fifth of the entire quantity of blood.

248. Probably there is more variation in individuals as to the *quality of blood* than there is as to the quantity. The old expressions, "rich blood," "poor blood," "blood will tell," etc., have much of truth in them in a physiological sense, for so-called "blood diseases" are often handed down from one generation to another, and blood may become so poor (thin and watery) from inattention to hygienic requirements that health is impossible.[1] On the other hand, pallor of countenance will disappear, and strength and energy return to the feeble when the poor blood has been enriched by good food, and air, and by warmth, cleanliness, and other hygienic measures.

249. In addition to the blood there is another fluid widely distributed throughout the body. This is the *lymph*, a liquid closely resembling in composition the blood plasma, and containing rounded corpuscles similar in appearance to the white globules of the blood, which are called "lymph globules." The lymph represents some of the ingredients of the blood which have traversed the walls of the blood-vessels and some of the products of disintegration, which, after renovation in the lymphatic system, enter the blood and are again serviceable in the

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[1] Living for a long time in an unhealthy atmosphere impoverishes the blood. Sometimes poor blood, as seen escaping from an injured vessel, is of a pale yellow color; not only are the red globules deficient in oxygen, but their number is materially decreased.

economy. The thin, delicate vessels in which the lymph currents move are the *lymphatics*.[1] These vessels (so fine that they cannot be readily seen until injected with quick-silver) begin as networks, or as tubes with free blind

Fig. 57.
Lymphatic vessels of a papilla of the palm of the hand, greatly magnified.

extremities, in the interspaces of the connective tissue, or of the capillary blood-vessels.[2] They are most abundant in organs well supplied with blood-vessels, such as the

[1] About the year 1600 the thoracic duct was discovered. In 1622 the lacteals, but until 1649 they were supposed to empty into the liver; in that year (1649) the receptacle for chyle was discovered, and the fact that chyle was carried into it, and from thence into the venous system. It was not until 1650 that the other absorbent vessels, *i.e.*, lymphatics, were discovered, first in the liver, and then in the other parts of the body.

[2] It is now supposed that certain serous cavities, such as the pleural and peritoneal, which were formerly considered as *closed* cavities, communicate by small openings with the lymphatics.

glandular organs, the mucous membrane, and the skin, — particularly that of the soles of the feet and the palms of the hands, — and are absent in the non-vascular tissues.[1]

250. The lymphatic capillaries, after leaving the various tissues, converge, the tubes becoming larger as they approach the heart. Those from the right side of the head and neck, and the right upper extremity, form the right lymphatic duct, which opens into the venous system at the junction of the right subclavian vein with the right internal jugular vein. The lymphatics of the lower extremities enter the abdominal cavity, and with the abdominal lymphatics (including the lacteals, with their contents the chyle), form the commencement of the thoracic duct. At the base of the neck, before this duct empties into the left subclavian vein, at its junction with the left internal jugular, it is joined by the lymphatics from the left side of the head and neck, and the left upper extremity. Thus the lymph is mingled with the venous blood before its arrival at the right side of the heart.[2]

Fig. 58.
Superficial lymphatics of the hand and forearm. — G, lymphatic gland.

251. In the course of the lymphatics everywhere in the body are

[1] Those instances related of blood-poisoning, by mere contact of poisonous material with the tender parts of the skin or mucous membrane, are probably due to the absorption of the poison by the lymphatics.

[2] According to Dalton, about six pounds of lymph (*i.e.* including chyle) is poured into the blood every 24 hours.

numerous glands, called *lymphatic glands*.[1] Their function, it is supposed, is a renovating or elaborating one. In them the lymph globules are believed chiefly to originate. Certain it is, that when in *large numbers* they are

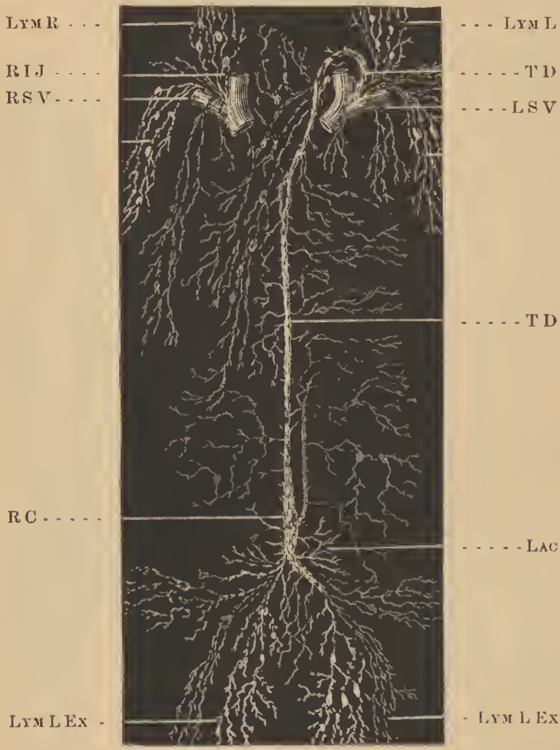

Fig. 59. — Diagram.

LYM R, lymphatics of right side of head and neck; LYM L, lymphatics of left side of head and neck; RIJ, right internal jugular vein; RSV, right subclavian vein; LSV, left subclavian vein; TD, thoracic duct; RC, receptacle of the chyle; LAC, lacteals; LYM L EX, lymphatics of lower extremities.

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[1] About 700. These glands are not infrequently enlarged; for instance, upon the head, or in the neck, from some irritation of the skin, from a sore throat, etc., and can then be readily felt.

hardened or otherwise altered, health fails, and the person grows thin, though the food may be suitable in quality and abundant in quantity.[1]

252. Intimately connected with the circulation of blood and the conveyance of lymph are the operations of secretion, transudation, and absorption, which form a large part of the processes of nutrition. Nutritive fluids and gases enter the blood, and by exosmosis and endosmosis, and by re-absorption, produce the secretions of the various organs, and the materials of the tissues. The "natural constitution of the parts, though constantly changing, is maintained in its normal condition, through the movement and renovation of the circulating fluids."

QUESTIONS.

1. State what is meant by the circulation, and what is its object.
2. What are the organs of circulation?
3. What is the chief organ, and where is it situated?
4. Name and describe in what the heart is enveloped, and its office.
5. With what is the interior of the heart lined?
6. What are the divisions of the heart, their location and object?
7. How does the blood pass from the auricles to the ventricles?
8. What keeps it from returning from the ventricles to the auricles?
9. What other valves are there in the circulation, and where?
10. By which side and parts of the heart is pure blood transmitted?
11. Which cavities of the heart are strongest?
12. Describe the circulation of the blood.
13. Does the heart, like other muscles, have rest?
14. What is the use of the stethoscope?
15. How are the movements of the heart effected? How affected?

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[1] The spleen, thymus gland (a gland found in children upon the front of the neck), and other ductless glands, in connection with the blood-vessels, elaborate in a similar manner formative constituents of the blood. When these glands are diseased, the blood is likely to be more or less white and watery.

16. What can you say as to its vitality?
17. Describe the arteries and their function.
18. How is the intermittent motion of the blood stopped, and where, and why?
19. What is the pulse and its rate?
20. What is the sphymograph?
21. What causes blushing and pallor? Apoplexy?
22. Describe the capillaries.
23. How are the nails, cartilage, etc., nourished?
24. Describe the veins.
25. By what is the circulation aided?
26. What of the rapidity of the circulation?
27. Does the blood flow to or from the heart in the arteries? In the veins?
28. Where then would you compress a bleeding artery to stop its flow? Where a vein?
29. What facts show the importance of blood?
30. Of what is blood composed?
31. How does it appear under the microscope?
32. What is the function of the red corpuscles?
33. What is the coagulation of the blood, and to what is it due, and of what use is it?
34. When does blood clot in the blood-vessels?
35. What is paralysis? A bruise? A hemorrhage?
36. What proportion in weight of the body is blood?
37. What effect has the quality of the blood upon the general health?
38. Describe lymph and the lymphatics.
39. Where do they begin, and where are they most abundant?
40. Where do they empty?
41. What are the lymphatic glands?
42. What processes of nutrition are intimately connected with the circulation of blood and lymph?

ANALYSIS OF THE ELEVENTH CHAPTER.

THE CIRCULATION.

- I. ORGANS
  - Heart
    - Structure.
    - How enclosed.
    - How lined.
    - Cavities
      - Auricles, right and left.
      - Ventricles, right and left.
    - Movements.
    - Sounds.
  - Blood-vessels
    - Arteries, Capillaries, Veins
      - Structure and functions.
      - Rapidity and force of circulation in.
- II. BLOOD
  - Value.
  - Composition.
  - Varieties.
  - Coagulation.
  - Quantity.
  - Quality.

LYMPH.

1. Conveyed, in lymphatics, — Lymph canals and lacteals.
2. Elaborated in lymphatic glands, — Number and location.
3. Composition and function.

CHAPTER XII.

RESPIRATION.—ANIMAL HEAT.

253. Blood, to nourish the tissues effectually, must contain oxygen. This is supplied by the atmosphere and by various foods, the largest amount being furnished by the air which we breathe. Simultaneously with the absorption of oxygen, the blood parts with its carbonic acid, and becomes pure. This process is effected by *respiration* or *breathing*. The *organs of respiration* comprise the lungs and the air passages leading to them. The *lungs* are two in number, and are located in the thoracic cavity, one on each side of the median line, and separated from each other by the heart and its great blood-vessels, and by the larger air-tubes. (Fig. 14.) Each lung is cone-like in shape, and extends upwards to the lower border of the neck. Its broadened lower surface is concave in form, and rests upon the upper convex surface of the diaphragm. The remaining surfaces of the lungs are convex in form, and fit into the concave interior of the chest walls.

254. *Free movements of the lungs are absolutely necessary for the full performance of their functions*, and are beautifully provided for by their structure and coverings, and by the arrangement and mobility of the chest walls. Covering each lung, except where the large blood-vessels and air-tubes enter, is a strong but delicately constructed, closed sac, similar to the pericardium, known as the *pleural sac*. These sacs are together known as the *pleura*, and

the space enclosed by each as the *pleural cavity*.[1] One wall of each sac is closely adherent to the lung, and the other to the concave inner wall of the chest. (Fig. 64.) The lining, or inner surface of each sac secretes in health just enough lubricating fluid to allow the inner surfaces of the walls of the sac to glide readily upon each other in the process of breathing.[2]

255. The lung substance, like a sponge, is *elastic*, and *filled with enclosures containing air*. If a piece of the healthy lung of an ox or sheep be pressed between the fingers, it yields a peculiar crackling, which is due to the partial dislodgement of air. If the piece be tightly squeezed, or even bruised between heavy rollers, sufficient air will still be remaining in it to cause it to float in water. In fact, the lungs are the only organs in the body that will float.

256. The *air passages* not only afford transit for the air, but they serve also to warm, cleanse, and moisten it on its passage to the lungs. They are the interior of the nose, the mouth, pharynx, larynx, windpipe or trachea, and the bronchial tubes.

257. Though air enters the mouth to a greater or less extent, the *nostrils are the proper channels of respiration*. The nose is especially fitted to warm, cleanse, and moisten the inhaled air. It is lined by mucous membrane, and is divided by a middle wall of cartilage and bone into separate nostrils, in each of which are three thin, projecting plates of bone, one above the other. These curve down-

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[1] The word *pleura* is derived from the Greek, and means "rib" or "side."

[2] When the gliding motions are hindered by the more or less intimate adhesion of the secreting surfaces of a pleural sac, as in pleurisy, anything more than the quietest breathing is attended with acute pain.

wards, and are covered by mucous membrane.[1] The air, therefore, in its passage through the nostrils, comes by a circuitous route into contact with a large extent of moist and warm mucous membrane. The membrane is kept moist by the secretions of its mucous glands, and warm by being richly supplied with blood.[2] In addition to these arrangements for warming the air, retarding its passage, and ridding it of dust, there are hairs just within the nostrils, and ciliated cells upon a portion of the surface of the mucous membrane of the nose. Similar cells are also found upon the posterior surface of the soft palate, in the windpipe, and other portions of the air passages. They are called ciliated because from them project ciliae, or hair-like, microscopical processes or filaments. These processes are constantly vibrating, but with greater force, in opposition to the entering current of air, or from within outward, their united movement somewhat resembling that of a miniature field of wheat when moved by the wind. The natural effect of such a moist and beautifully contrived organism, opposing itself to the entering air current, is to catch from it foreign particles which may be intermingled with it, and gradually carry them, by an unceasing counter movement, out of the air passages.

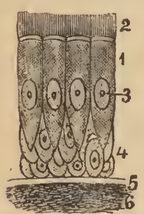

Fig. 60.
Diagram of a vertical section of the bronchial mucous membrane.—1, ciliated epithelial cells; 2, ciliae; 3, nuclei; 4, new cells; 5, basement membrane; 6, fibrous layer.

258. On the other hand, when we *breathe through the mouth*, foreign particles are forced into the throat and

[1] These bones are known as the "turbinated" bones, from their fancied resemblance to tops.

[2] It is said that the nasal cavities are a degree or two warmer than the cavity of the mouth.

lungs, and act as irritants, the mouth and throat become dry, and sufficient time is not taken for the mastication of food, so imperative is the necessity for breathing.[1] In the habitual mouth breather, the nasal mucous membrane, being insufficiently used, dries and shrinks, causing discomfort. The efforts that are necessary to breathe with comfort after a while result in more or less lasting unpleasant expressions of the face;[2] the mucous membrane is liable to become more or less inflamed, and thus to obstruct the nasal passages; hearing is interfered with by partial or entire closure of the Eustachian tubes, whose function it is to convey air to the organs of hearing; the voice loses its resonance, and the lungs are imperfectly developed. Sometimes the tonsils, or almond-shaped glands, located one on each side of the throat, enlarge, and obstruct the free movement of air through the nasal cavities and Eustachian tubes. (Fig. 33.)

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[1] Healthy babies breathe, for the larger part of the time, through the nose, with the mouth shut; and, if a baby is in the habit of breathing with the mouth open, there is reason to suspect the presence of enlarged tonsils, or some disease of the nostrils. A Scotch physician, fully appreciating the importance of proper breathing, has written a valuable medical paper, entitled "Shut your mouth and save your life." We are told that some Indian tribes understand the importance of breathing through the nose, and that the squaw, before retiring for the night, sees that the mouth of her babe is shut. Some of the most careful trainers of pedestrians insist that walking and running should be, as far as possible, with the mouth closed.

[2] "Air inspired through the nose passes through a refining process, which prepares it for the lungs very much as mastication prepares food for the stomach. If food is improperly masticated, the stomach suffers. If air is improperly refined, the air passages suffer. The *nose* and not the *mouth* was designed as the gateway to the lungs. . . . The mouth may be closed on going to sleep, opened while sleeping, and when consciousness arrives, is closed again, and so many are ignorant of the fact that they ever breathe through the mouth. If these people are questioned closely, the fact will be elicited that the mouth and throat are always dry in the mornings, and that it may be several hours before this condition wears away. . . . When dryness of the throat is caused by sleeping with the mouth open, if the nasal passages are found to be sufficiently large to supply the lungs with air, the mouth should be kept closed by wearing a skull-cap with strings or straps fastened to its sides, which, being tied or buckled under the chin, hold the jaws together." — THOMAS R. FRENCH, M.D.

If, as is sometimes the case with babies and young children, whose bones are deficient in mineral ingredients, the blockage is long continued, there results, from the repeated violent efforts in breathing made necessary, a more or less permanent sinking in of the lateral chest walls, thus causing an unnatural protrusion in front. This condition is popularly known as the "pigeon breast."

259. The *pharynx* (before described in connection with the alimentary canal) is a passage for air as well as food, though the organs of respiration are sometimes said to begin with the *larynx*, or voice box. This latter organ is located in front of and adjoining the upper end of the oesophagus. (Fig. 33.) It is composed of several cartilages controlled by muscles, and is so arranged as to form a kind of box. About the middle of it is a dilatable opening called the glottis, through which respiration is performed, and by means of which articulate sounds are produced.

260. The *trachea* is a membranous and somewhat elastic tube, about an inch in diameter, and four and a half inches in length, which extends downwards from the larynx. About opposite the middle of the third dorsal vertebra it divides into smaller tubes, called the right and left *bronchial tubes*, which enter the lungs. These in turn divide and subdivide like the branches and twigs of a tree, becoming smaller and smaller, until they finally end in "lobules," *i.e.*, oval sacs or bags.

The walls of the trachea are held apart by a series of imbedded cartilages, called rings, placed at nearly equal distances from each other. These rings are also found in the larger bronchial tubes. They are not complete rings, however, for they do not meet posteriorly, an arrangement which gives them elasticity and pliancy, and allows

the oesophagus to expand readily in swallowing. These rings prevent the collapse of the walls of the trachea and bronchial tubes in respiration.

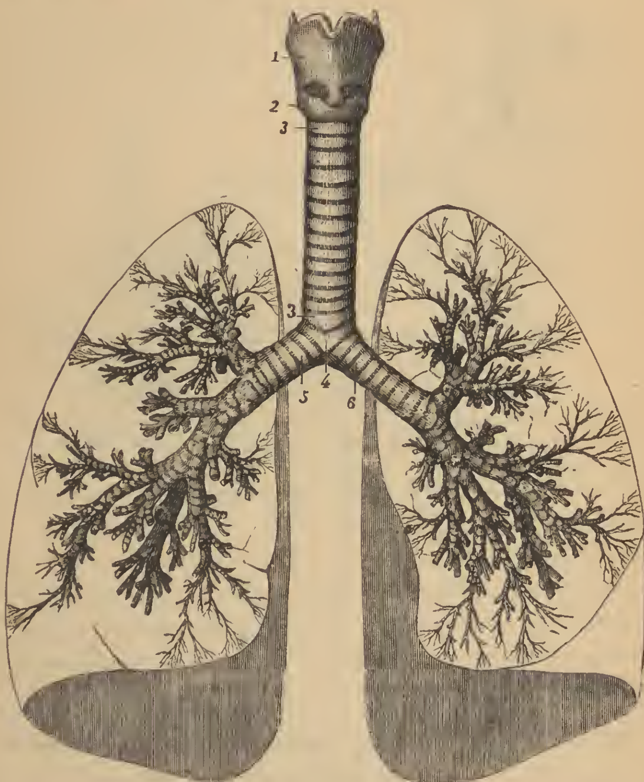

Fig. 61.

Lungs in outline, showing relations of the larynx, trachea, and the bronchial tubes and their branches. — 1, thyroid cartilage of the larynx; 2, cricoid cartilage; 3, trachea; 4, its point of bifurcation; 5, right bronchial tube; 6, left bronchial tube.

261. The smallest air-tubes, or bronchioles, have delicate, elastic, membraneous walls, without cartilages. The *lobules* in which they end are divided into secondary

compartments by thin partitions projecting from their inner surfaces. Each compartment or pulmonary vesicle, as it is technically called, is only about one seventy-fifth of an inch in diameter, and its walls are very thin, elastic, and distensible.

Fig. 62.
Ultimate bronchial tubes and their lobules.

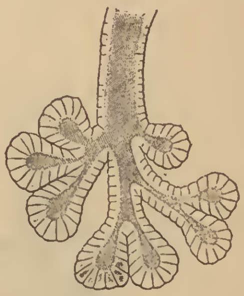

Fig. 63.
Lobules laid open.

Covering the lobules, and dipping down between the adjoining walls of the air vesicles, is the network of capillary blood-vessels referred to in the last chapter. The convoluted arrangement of the walls of the lobules affords an extensive surface of very delicate membrane for the aeration of blood,—a surface much greater than that of the entire exterior of the body.[1]

262. The *process of respiration* consists of *inspiration*, or breathing in, and *expiration*, or breathing out. In inspiration the glottis is more or less widely opened, the chest walls are drawn outward and upward by muscles overlying the chest, and by muscular fibres between the

[1] It is estimated that the extent of surface of all the vesicles is about 1400 square feet, and that "in the course of twenty-four hours about 20,000 litres (35,000 pints) of blood traverse the capillaries, the blood corpuscles passing in single file, and being exposed to air on both surfaces."

ribs,[1] and the diaphragm is caused to descend by the contraction of its muscles. The thorax is thus dilated, and, in consequence, the elastic air vesicles are filled with air forcibly sucked in, as it were, somewhat as air is drawn into a syringe. The normal enlargement of the thorax is in three directions; viz., vertical, from side to side, and from before backward. The first — that due to the descent

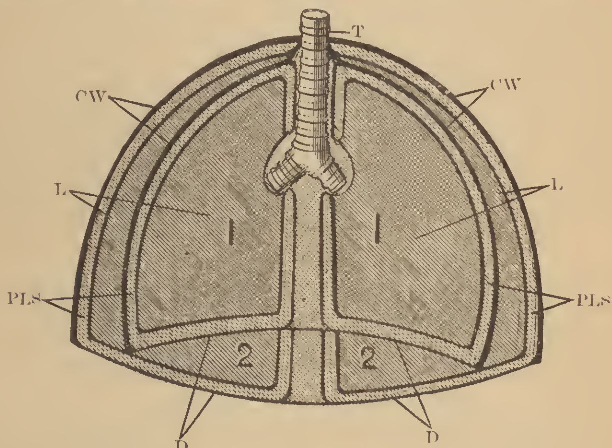

Fig. 64.

Diagram. Lungs in inspiration and expiration. — 1, lungs contracted in expiration, 2, lungs expanded in inspiration; T, trachea; CW, chest walls; L, the lung substance; PLS, pleural sacs (the walls separated); D, the diaphragm.

of the diaphragm — is the greatest, and is especially marked in young children. The enlargements from side to side, and from before backward, are most marked in the lower part of the chest of the adult male, and in the upper part of the chest of the adult female. These methods of enlargement constitute what are called "types of respiration."[2]

[1] There are two sets of muscles between the ribs; viz., the internal and external intercostal muscles. The first, by contraction, assist in pulling the ribs down; the second serve to pull them up.

[2] The vertical breathing, in which the diaphragm descends, and the abdominal walls and contents are pushed forward, is the *abdominal type*. The side-to-side enlargement is the *inferior costal*, and the from-before-backward enlargement is the *superior costal* or *pectoral* type.

263. *Expiration* immediately follows inspiration, is a passive movement, and consists in the gentle expulsion of the air outward through the air passages by the elastic recoil of the respiratory apparatus.[1] After each expiration there is a short period of rest.[2] When more than ordinary respiratory efforts are necessary, as in oratory, singing, blowing upon wind instruments, etc., increased expiratory force is created, and the elastic recoil is aided by the powerful contractions of large abdominal muscles, which, pulling down the ribs and pressing upon the contents of the abdomen, forcibly push up the diaphragm, and thus squeeze out the air from the lungs. Corresponding inspiratory power results from a forcible contraction of the diaphragm and of the respiratory muscles of the chest.[3]

264. In children, especially under three years of age, breathing is effected mainly by the contractions and relaxations of the diaphragm.[4] As the person grows older and

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[1] By placing the ear over a healthy lung, we can hear the strong movement of the air as it enters the chest. Expired, it gives a low-pitched sound, as of a very gentle wind. Variations in the pitch, volume, and quality of these respiratory sounds or "murmurs" enable the physician to detect diseases or disturbances.

[2] According to Dr. Burdon Sanderson, the relative durations of the periods of *inspiration*, *expiration*, and *repose* are to each other as 4:2:9, the duration of the whole respiratory act being represented by 15.

[3] In violent inspiratory efforts, following severe physical exercise, or when the action of the lungs is much impeded by disease, nearly all the muscles of the body may assist the respiratory muscles proper, by fixing various parts of the body so that the respiratory muscles may have the best opportunities for work.

[4] The action of the diaphragm in respiration is well illustrated with an open bell jar, whose lower and larger opening is tightly covered by thin rubber. Place a snugly-fitting cork in the neck of the jar, and through it put a glass tube, one end projecting above the opening of the neck, and the other end with a thin rubber bag or pouch firmly secured to it, nearly midway into the body of the jar. By pulling the rubber covering of the jar downwards, air will enter the tube at its upper end, and distend the bag, as in inspiration. When let go, air will be forced out, as in expiration.

the muscles become larger and stronger, the from-side-to-side and from-before-backward types of breathing become in the lower or upper part of the chest more marked. But at all periods of life, the free action of the diaphragm is especially necessary. Though mainly composed of involuntary muscular fibres, the diaphragm is, to a certain extent, under the control of the will, and its strength, like that of the other respiratory muscles, can be increased by proper exercise, such as singing, reading aloud, oratory, etc.[1] Hiccoughing, sobbing, and laughter are occasioned by the spasmodic action of the respiratory muscles, especially of the diaphragm. Laughter, crying, and sobbing, though generally under the control of the will, may become violent and uncontrollable, as is sometimes witnessed in the anger or sorrow of children.[2]

265. The *movements of respiration* are for the most part involuntary. From birth until death, asleep and awake, breathing, like the circulation, goes on involuntarily. There should be in adults one act of respiration to every four or five beats of the heart, and, in children, one to every three or three and one-half beats. But one can increase somewhat the rapidity of the respiratory movement up to his limit by various forms of exercise. With such increase, the heart's movements must proportionately increase, or exhaustion and suffering ensue from "shortness of breath." On the other hand, if the heart beats

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[1] Physicians frequently meet with persons, especially those of sedentary occupations, whose breathing is shallow, the air-cells of the lungs expanding but very little. Oftentimes by proper exercise of the muscles of the chest and diaphragm (*i.e.*, by so-called lung gymnastics), the respiratory power can be increased to a marked extent, and incipient disease of the lungs warded off.

[2] It sometimes happens that persons having the charge of children are very severe upon them for persisting in sobbing, when it is utterly out of their power to desist. Fortunately, in general, nature teaches parents to avoid this blunder.

rapidly from severe exercise, and the movements of the lungs do not proportionately increase, either on account of disease or restraint by tight clothing, the individual suffers in like manner, and is "out of breath."

266. Soon after birth the *number of respirations* are about forty-five per minute; at five years, twenty-six; from twenty to twenty-five years, nineteen; about the thirtieth year, sixteen; and from thirty to fifty, eighteen. The above is the average rate, but it is naturally more rapid where there is small lung capacity, or when breathing rarefied air at great heights, or when taking exercise, walking, singing, etc. Of course, therefore, where the contrary to these conditions exists, the rapidity is decreased.[1] Few persons can, without great effort, suspend respiration for more than thirty or forty seconds at any one time. The desire for breath soon becomes imperative, owing to the circulation of blood of rapidly-increasing impurity, especially in the lungs and brain. By breathing forcibly for a few times, then taking a forced inspiration, respiration may be suspended for a minute, or even longer, thus enabling one to pass quickly through a cloud of dust, smoke, or other injurious matters in the atmosphere, or to remain for a short time under water.[2]

267. The *quantity of air breathed* varies. In ordinary breathing, during each act of respiration an average of twenty cubic inches of air, or about two-thirds of a pint, are inhaled and exhaled. This is called the tidal air, because it is the ordinary amount which ebbs and flows

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[1] In fact, the rate of breathing varies, and has been found to be as low as 9, and as high as 40 per minute, in different persons, when seated, and, as far as possible, under the same conditions.

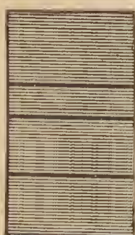
[2] This ability to hold the breath can be increased by systematic practice, as in the case of the "water-kings and queens," who sew, write, and eat under water.

in breathing. It is said not to penetrate, by the ordinary movements of inspiration, farther than the large bronchial tubes. But by the process known as gaseous diffusion, the heavier carbonic acid in the air-cells and the vivifying and lighter oxygen in the bronchial tubes are mutually intermingled. But this intermixture of gases in ordinary breathing only partially renovates the air in the various parts of the lungs. It is estimated that from eight to ten respirations are necessary to change the whole quantity of air in the chest cavity. From what has been said it will be understood that in quiet, ordinary breathing about six quarts of air pass into and out of the lungs every minute, or about ninety gallons per hour, or sixty barrels per day. Large as this amount is, it is not sufficient for healthy persons during active exercise, or for any one, if the atmosphere be vitiated by impurities. *Continued ordinary* (or tidal air) *breathing*, such as is common among persons engaged in sedentary occupations, *is insufficient for the healthy* development of the lungs. For this reason, among others, systematic exercise in the open air is important. Were it not for the more profound inspiration and expiration which usually occurs at about every fifth or sixth act of respiration, whereby an increased amount of air is carried into and out of the lungs, such persons would suffer more than they do from the excess of carbonic acid not eliminated.[1]

268. It has been already stated that a healthy lung contains air which cannot be expelled. This is called *residual air*. The air which remains in the lungs after an ordinary expiration, but which may be expelled by a forced

[1] It is well known to physicians that persons with "shallow respirations," either because of sedentary occupations, or from habit, or tight clothes, are most likely to suffer from consumption and other lung diseases, especially if the air breathed is impure.

expiration, is termed *reserve air*. By a forcible inspiration after an ordinary inspiration, an average of about 120 cubic inches of air may be inhaled. This is known as *complemental air*. The extreme breathing capacity, or *vital capacity*, as it has been called, is equal to the volume of air which can be expelled from the lungs by a forcible expiration following a deep and forcible inspiration. It may be determined by an instrument known as



Complemental air	100 to 120	cubic inches.	
Tidal air	20 to 30	"	"
Reserve air	75 to 100	"	"
Residual air	75 to 100	"	"

Fig. 65.

If the above diagram represent the greatest amount of air that can be inspired, then the different divisions will approximately represent the complemental, tidal, reserve, and residual air.

the spirometer,[1] and is found to be, in a person of average stature (5 ft. 8 in.) about 230 cubic inches; but the vital capacity is no evidence of itself of vitality or endurance, or so-called "wind," for it bears a definite relation to stature, without being affected in a marked degree by weight or the circumference of the chest."[2] It is diminished by severe thoracic and abdominal diseases;

[1] Commonly called "lung-tester."

[2] It has been shown by Hutchinson of England, who has made the most numerous investigations in this direction, and who makes the above statement, that for every inch in height between five and six feet, the vital capacity is increased eight inches. It increases up to the age of thirty-five, and then diminishes.

but the vitality of an individual depends more upon the condition of the heart than upon the expansive capacity of the lungs.

269. The *changes that take place in the air during respiration* are as follows: *Inspired air* is robbed of a large part of its oxygen, which is appropriated by the blood between the adjacent walls of the air vesicles. At the same time the air acquires various matters, the results of tissue changes, which have been brought to the air-cells by the circulation. Hence, *expired air* is charged with noxious materials, and will not support combustion or maintain life. Animals and human beings obliged to breathe it exclusively soon die. It contains carbonic acid[1] in excess, and small quantities of various excretory products similar to those excreted by the skin and kidneys;[2] also, an animal matter which is offensive and very prone to putrefy. It differs also from inspired air in that its temperature, especially in slow and tranquil breathing, is raised to nearly that of the blood, and because it contains an excess of watery vapor.[3] This vapor is especially noticeable when the breath is exhaled upon a mirror or window pane, or when it condenses in winter, as it issues from the mouth and nostrils.[4] Carbonic acid gas is heavier than air, and is very poisonous to breathe. It constitutes about one twenty-fifth of the air that passes out of

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[1] The amount of carbonic acid exhaled per day by a healthy adult is estimated at about 32,000 cubic inches, while the amount of oxygen consumed per day is estimated at about 40,000 cubic inches.

[2] "Chloride of sodium, uric acid, and urates of soda and ammonia. It also sometimes contains carbonate and hydrochlorate of ammonia, and carburetted hydrogen and various odorous substances from the food and drink consumed."

[3] The air exhaled per day contains an average amount of nine or ten ounces of water, but the amount varies with the temperature of the atmosphere.

[4] In cases of suspected death, the condensation of the watery vapor of the breath upon the glass of a watch or a hand-mirror is an important evidence that life is still present in the body.

the lungs, and tends to make the atmosphere impure. The amount of carbonic acid expelled is increased by exercise, and during and after a hearty meal. It is greatest in winter and damp weather, and is especially abundant in the early morning, and is least at midnight.[1] (*a*.)

270. There are also *changes in the blood during respiration.* The ancients believed that the function of the air so regularly introduced into the lungs was to cool the blood. The chemist Lavoisier first ascertained that inhaled air was rich in oxygen, and exhaled air in carbonic acid. Physiologists, after prolonged and difficult investigations, found, first, that associated with these changes in the air was the striking change in the color of the blood from blue in the pulmonary veins to scarlet in the capillaries of the lungs. Second, that this change was due to the inhaled oxygen. If the breathing is seriously obstructed, the lips and face turn a purplish blue. If the obstruction be removed, the blood resumes its bright color, and the parts renew their functions. If the obstruction be not removed, the change in color is noticeable in other parts of the body, impure blood is circulated through the brain, and the individual becomes drowsy and unconscious, and death ensues. There is constantly going on in the blood a double change, — a loss of oxygen, and a gain of carbonic acid in the tissues; and a loss of carbonic acid, and a gain of oxygen in the lungs.

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[1] The presence of carbonic acid in the breath may be illustrated by the following experiment, which is all the more striking if tried after one has talked or sung awhile, or after a hearty meal. First, the gas, being *acid*, will change the blue color of a solution of litmus to a red, when the breath is gently blown into the solution through a glass tube for a variable length of time. Second, that the expired air contains *carbonic* acid will be shown by changing clear lime-water, in the same manner as above, to a cloudy white liquid, due to the carbonate of lime formed.

The urgent appeal of the lungs for pure air, when the breathing has been carried on in an impure atmosphere, or where the lungs are in a diseased or abnormal condition, is like the appetite for food on the part of the digestive organs. The cry originates in the tissues, which demand, in the one case the food, and in the other the oxygen, which are necessary to life. Carbonic acid is not only discharged by the lungs, but also by the kidneys and skin. In fact, as we have seen, the skin is an accessory organ of respiration, taking in oxygen, as well as giving out carbonic acid. In some of the lower forms of animal life the skin is the active organ of respiration.

271. *Animal Heat.* It has been already stated that the living bodies of all animals have a *temperature* peculiar to each species. This is known as the *vital* or *animal heat.* Where the temperature is generally higher than that of the surrounding atmosphere, as in man, quadrupeds, and birds, the animals are distinguished as warm-blooded animals, while fishes and reptiles are known as cold-blooded animals, their temperature varying but little from that of the air or water in which they live. It was at one time supposed that the sole internal cause of this heat was the combustion of carbonaceous material in the lungs. At present it is known that "the production of heat in living organisms is in proportion to the activity of their internal changes. These changes are especially indicated by the absorption of oxygen and the exhalation of carbonic acid." While it is true that the more rapid the respiration the higher the temperature, heat production is not exclusively connected with respiration, but is essential to *all* the manifestations of animal life. Animal heat remains in the body for a variable period after the blood has ceased to flow and respiration has stopped and the in-

dividual is said to be dead. Instances are on record of life being restored by the application of heat to the body, both externally and internally, and by arousing the circulation and the action of the lungs by means of electricity, the practice of artificial respiration, and the use of stimulants.[1]

272. Animal temperature is usually ascertained by means of a thermometer made for that purpose.[2] When in use the bulb of the instrument is generally placed in the armpit, or under the tongue, the lips being closed to exclude air. The temperature so ascertained is, in man in health, 98½° F. to 99° F. A temperature of 105° generally marks a severe attack of some disease; one above 105° indicates great danger, and a "temperature of 110° to 112° is very quickly fatal, unless it yields to the application of cold." Seldom does the temperature fall below 91.4° F. One of 96° indicates great danger, and, to use a medical term, is a symptom of commencing "collapse." Below 92° the possibility of recovery is small.

Though the average normal temperature, as ascertained by the thermometer, is about 98½° F., the general temperature of the interior of the body is about 100° F.; but the temperature of different parts of the body varies somewhat. In the skin and lungs, by reason of the contact of air and the vaporization of water, the blood is cooled a little, and the animal temperature is slightly diminished. On the other hand, the temperature is raised in the muscles and glandular organs, especially during their functional activity, and, above all, in the liver.

273. It is also *modified*, first, by *age*, being higher in the young child than in the adult; second, by the *period*

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[1] See Emergencies, page 324.

[2] Known as a "medical" or "clinical" thermometer, designed especially for the use of physicians.

of the day, rising quickly in the morning, more slowly towards night, and being lowest about midnight; third, *by food*, rising during and after the digestion of a meal, especially of warm food. It is increased also by *muscular* and *mental exertion*, and by *surrounding higher temperatures*, and, of course, is lowered by the opposite conditions. Exposure to moisture and a high degree of heat, especially if accompanied with exercise, is apt to cause death, which is then said to be the result of "sunstroke" or "heatstroke."[1] The old, the feeble, and the inactive are most affected by high temperatures, and in them also animal heat is maintained at its normal point with the greatest difficulty. With them the blood circulates more slowly, vital, chemical, and mechanical processes take place less rapidly, and heat is generated in smaller amount than in robust health. "Thence it is," says Bennett, "that the old man seeks the sun, and that we find him in the country sitting at his door for hours, basking in the sun, seeking from its genial rays the warmth which the organic processes no longer afford, as in former days, the days of his youth, and of his organic vigor."

274. In summer and in hot countries perspiration and a decreased amount of clothing moderate the animal

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[1] The terms "preternatural combustibility" and "spontaneous combustion" have been applied to the rapid destruction of the human body by fire, which has been supposed to have resulted from excessive animal heat. "It is significant that no case of spontaneous combustion has ever happened in an animal. Of all the so-called cases in man, not one has actually been seen to happen. . . . Such occurrences usually take place in persons addicted, during their life, to habits of intoxication. . . . It is rational to conclude, more especially as habitual drunkards are incapable of exercising care in regard to sources of danger, that they have themselves, in a state of intoxication, set fire, in falling, or otherwise, to their clothes or other combustible materials, or that they have been reached by flames, otherwise occasioned by the falling of candles, or by the emission of sparks from the fire." — *Outlines of Physiology*. MARSHALL.

temperature; in cold climates and seasons the heat of the body is preserved by extra clothing, and by warming the atmosphere with artificial heat, by more exercise, and an increased amount of food. It is the testimony of many observant travellers, that the health of persons journeying from one climate to another is best preserved when the customs of the inhabitants of these climates are followed, in regard to food, exercise, and clothing. (*a.*)

QUESTIONS.

1. What is the object of respiration, and what are its organs?
2. Describe the lungs, and how free movements of them are secured.
3. Name the air passages and their four functions.
4. Describe the nose, and its advantages over the mouth as an air passage.
5. With what passage do the nasal cavities connect, and what tubes and glands are there located? State the object of the tubes.
6. How may enlarged tonsils cause a child to become pigeon-breasted?
7. What is situated below the pharynx, and of what air passage is it the commencement?
8. Describe the larynx; the trachea; the bronchial tubes; the lobules.
9. How are the trachea and other air-tubes kept open? How the smaller tubes?
10. Why do these tubes terminate in convoluted lobules, and what blood-vessels are there placed?
11. Of what does the mechanical act of respiration consist? Describe each process.
12. What may aid powerful respiratory efforts? Describe the action of the diaphragm.
13. What connection has the will with respiration? the heart? the condition of the blood?
14. Explain what is meant by tidal air; by residual air; by reserve air; by complemental air; by vital capacity.
15. What changes take place in the air during respiration? in the blood?
16. Where does the appeal for fresh air originate, and how is the needed oxygen supplied through the lungs?

17. In what other way is oxygen introduced into the system?
18. Define animal heat. What are its sources, and by what is it affected and regulated?
19. What is the average degree of temperature in health, as ascertained by the thermometer?
20. What is the average temperature of the interior of the body?
21. How can we maintain the normal temperature of our bodies?

ANALYSIS OF THE TWELFTH CHAPTER.

RESPIRATION.

I. OBJECT.

II. ORGANS . . . .
- 1. Lungs . . . . { Structure. Functions.
- 2. Air passages, — or nose, mouth, pharynx, larynx, trachea, and bronchial tubes. } Structure. Functions.

III. MECHANISM, — Inspiration and expiration.

IV. AMOUNT OF AIR BREATHED.

V. EFFECTS . . . { Upon the air. Upon the blood.

ANIMAL HEAT.

I. CAUSES.

II. NECESSITY.

III. RANGE IN HEALTH AND DISEASE.

IV. HOW MODIFIED.

CHAPTER XIII.

AIR. — DISINFECTION. — LIGHT.

275. So well is man adapted to the *atmosphere*, that its density cannot be much increased or diminished without interference with the circulation, respiration, and other vital processes. The thickness of the atmosphere is supposed to be not less than 45, and not more than 200 miles; and the pressure of this immense mass at the sea level is computed to be 15 lbs. upon every square inch of surface. Upon the body of a man, therefore, of average size, it is more than *sixteen tons*.[1] This pressure, enormous as it appears, is of vital importance to the animal economy. At great heights, where atmospheric pressure is diminished, breathing becomes exceedingly difficult, or impossible. Not only does the rarefied air not furnish sufficient oxygen to the lungs, but carbonic acid is imperfectly eliminated, and owing to the diminished pressure upon the blood-vessels, that pressure is overcome by the force of the circulation, and bleeding may occur from the nose, mouth, and ears.[2]

276. In deep subterranean and submarine excavations, such as mines, tunnels, etc., the atmospheric pressure is so increased that the workers in them are often disabled. Sometimes in the construction of the piers of such large bridges as that over the East River, between New York and Brooklyn, it is necessary to sink an immense inverted

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[1] The surface of a man's body of medium size is about fifteen square feet.

[2] In the reports of the dredging operations of H.M.S. *Challenger*, it is said: Fish were brought up from great depths distended and deformed, with their swimming bladders protruding from their mouths, because, on coming to the surface, the great pressure under which they were accustomed to live was removed.

box or "caisson," in which men work, digging out the earth for the foundations. As the earth is excavated, the caisson sinks, and the air which it is necessary to pump in becomes exceedingly dense, and its pressure equals the pressure of the water without.[1] Such dense air is as injurious as exceedingly rarefied air, producing severe neuralgic pains, great prostration, hemorrhages, or paralysis.[2]

277. *Atmospheric air is a mixture*, the essential ingredients of which are *oxygen*, *nitrogen*, *carbonic acid*, and *watery vapor*. The first two exist in the proportion of one part in bulk of oxygen to four parts of nitrogen. The amount of carbonic acid is very small at ordinary elevations, or about one gallon in every 2500 of air. Its presence in the atmosphere is shown by the film of carbonate of lime which forms upon lime water when exposed to the air. The amount of watery vapor depends largely upon the temperature of the air.[3]

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[1] "Sometimes in deep mines, and in works conducted under water, as in laying the foundations of bridges, the pressure of the air is as much as sixty or seventy pounds avoirdupois on the square inch . . . Great care should be taken that those who are subjected to such high pressure be not suddenly exposed to air at the normal pressure, for the effect is equivalent to the application of a gigantic cupping-glass to the whole body." — *Human Physiology*. POWERS.

[2] "Caisson disease" has seriously impaired the health of the chief engineer of the East River Bridge, and also that of some of the workmen. At the St. Louis Bridge, when one of the caissons touched a rocky bed, the atmospheric pressure was 45 lbs. to the square inch, and by the rise of the river it was increased to 50 lbs. When the pressure was 34 lbs. *severe* suffering began. It was found that the men could only work one or two hours at a time. They were generally taken sick when coming out of the air-lock into the normal atmosphere, seldom in the air-lock itself.

[3] "It seldom forms more than $\frac{1}{80}$th, or less than $\frac{1}{200}$th of the bulk of the air." — *Chemistry of Common Life*. JOHNSTON.

That water is present in the air is seen by its condensation in drops upon an ice-cold vessel — a pitcher or tumbler of ice-water — in hot weather; also in the dew, hoar frost, fog, rain, and snow, and in the effect on certain solid substances which have the property of combining with water and becoming liquid. Such substances, of which calcium chloride is an example, are said to be *deliquescent*.

278. In the specimens of air that have been examined from time to time in different localities, and at varying altitudes, the relative proportions of oxygen and nitrogen have been found to vary but little, but the amounts of carbonic acid and watery vapor materially. *Other ingredients* are occasionally present in appreciable quantity; viz., ozone, ammonia,[1] nitrous and nitric acids, dust, and gases from marshes, factories, chemical works, etc.

279. *Oxygen*, as we have seen, is necessary to purify the blood and sustain life. Animals usually die when the quantity of oxygen in the atmosphere is reduced from three to five per cent. Without it, combustible bodies would not burn. Its dilution with *nitrogen*, which is a harmless, inert gas, is in the exact proportion which is best required to support life, and that degree of combustion which is most useful to the ordinary purposes of mankind. Any diminution of its normal amount is attended with as bad results as is the addition to air of harmful substances. On the other hand, were the oxygen in excess, it would become a very destructive agent, and in proportion to that excess. In such cases the tissues of animals would be rapidly consumed, together with all bodies having any chemical affinity for oxygen, and such as were set on fire would burn beyond control. But, as in the case of other nutritive substances, we cannot live on oxygen only. Just as we find the most valuable food constituents to become less valuable when used alone, so oxygen requires also to be diluted with the other ordinary constituents of the air to become even respirable.

280. As the diamond, charcoal, and graphite are different forms of carbon, so *ozone* is a form of oxygen, but has greater chemical activity as an oxidizing agent; hence,

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[1] Of ammonia there are about 3½ gallons in 10,000,000 gallons of air.

it is a powerful disinfectant, and is recommended for the purification of sick rooms.[1] It exists in very minute quantity in the air, and thus diffused, is considered a stimulating agent in debilitated conditions of the system. It is much more abundant in the country than in towns, and its quantity is increased just after a thunder storm. Air highly charged with ozone is irrespirable, and is capable of bleaching and destroying vegetable coloring matters.

281. It sometimes happens that air is rendered more or less injurious by the accumulation of dust and other *suspended matters*, or by an undue proportion of one or more of its normal constituents, or by the addition to it of poisonous gases.

A ray of sunlight in a darkened room, or in the open air, upon a foggy day, reveals in its track myriads of shining particles of dust, however clear the atmosphere may otherwise seem. From the researches of Tyndall, Pasteur, and others, we know that this dust consists, according to the place, in varying proportions, of starch granules, cotton fibres, spores, seeds, pollen, and cellular tissue, of wool, hair, epidermal cells, and other animal substances, — sometimes in a state of decay, — of particles of carbonaceous and siliceous or flint-like matters, and of microscopic organisms in a living state.

282. These substances come from factory and home fires, from the combustion and decay of animal and vegetable bodies, from the "wear and tear" of wooden and stone pavements, shoe-leather, furniture, carpets, upholstery, clothing, etc. From hundreds of sources these suspended matters are wafted by the winds, and some

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[1] The quantity varies at different times and places, but is said to be, at the most, about one volume in 700,000 of air, and is quite constant in the atmosphere among pine trees. Ozone passed through a mass of putrifying material will rid it of noxious odors.

believe are also carried by flies, mosquitoes, and other insects. They are found almost everywhere, even penetrating close joints of carpentry work. When in large quantity in the air, as at times in cities, they are frequently irritating to the respiratory organs, especially of feeble people. In such cases it is advisable to protect the mouth and nostrils by a handkerchief, tippet, or veil, or a piece of cotton wool or sponge, or any other object through which the air can be breathed, and at the same time the dust be prevented from entering the air passages.[1] In the same way the temperature of very cold air may be mitigated, and be more safely breathed.

283. In addition to the substances already mentioned, it is believed by many physicians, that at certain times there are wafted through the air peculiar particles called "*disease germs*," which are capable of producing, according to their kind, particular diseases, such as small pox, scarlet fever, diphtheria, yellow fever, etc., — each disease having its own peculiar germ. (*a.*) The "*germ theory*" of infection has arisen from observing the manner in which the thistle and other plants spring up in various parts of the world, in consequence of the wide diffusion of their seeds by the winds. (*b.*) The development of these germs is believed to be as rapid as is that of the spores of the yeast plant, when for both there are favorable conditions of warmth and moisture, and the former have a feeble human body as a nidus for development, and the latter fermenting material. Disease germs may lie dormant in cold weather, or where their surroundings are

[1] In certain occupations, such as stone cutting, metal polishing, knife and glass grinding, or in white lead works and other manufactories, the dust is so plentiful and irritating at times that "respirators" are worn, consisting of frameworks of wire gauze, made to fasten over the mouth and nostrils, and containing a piece of sponge, cotton, wool, or other similar substance slightly dampened.

clean, only to grow and develop in the presence of moisture and filth, and be carried long distances in merchandise and clothing, especially in woollen materials.[1] Complete isolation and cleanly surroundings of persons with infectious diseases (*i.e.*, quarantining) will generally prevent the spread of infection.[2]

284. *The organic nitrogenous matter* which is thrown off from the lungs, mingled with carbonic acid and watery vapor, does much towards vitiating the atmosphere. Its exact composition has not been ascertained. It has a disagreeable, persistent odor, and is known to be poisonous.[3] Combined with the emanations from the skin and other impurities, the mixture gives to the atmosphere of a crowded room that odor which is so disagreeable to those who enter the room from the outer air, or that close, oppressive sensation, perceived so often in the unventilated rooms of tenement houses.

Air containing such ingredients ordinarily acts as a subtle poison, undermining the health, and changing the character of the blood, especially of those who are obliged to spend much of their time in it, and who do not exercise in the open air. It becomes exceedingly poisonous if breathed and rebreathed by a large number of persons in

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[1] It is believed by Prof. Tyndall and others, that "disease germs" are among the most dangerous ingredients of the air of drains and cesspools, and only need the proper surroundings for their development. They may be conveyed also by milk and water. Children and feeble persons are most susceptible to their influence.

[2] It is related that in the Scilly Isles, for ten consecutive years, there was not a death from, and only mild cases if any at all of, measles, scarlet fever, or small pox, though such diseases were very prevalent upon the mainland, with which there was little communication.

[3] In an experiment by Dr. Hammond, a mouse confined in an atmosphere of carbonic acid gas breathed with difficulty. When some of the organic matter was removed from the atmosphere, although the air was still loaded with carbonic acid, the mouse breathed more freely.

close quarters, and the condition produced is known as *ochlesis* or "*crowd poisoning*."

The history of the past gives fearful instances of such poisoning, but to a greater or less extent it is still to be found in many tenement and cheap lodging houses, in the holds of some emigrant vessels, in overcrowded schools, churches, and theatres, and especially in cheap places of amusement. (*a.*) Formerly, overcrowding with its consequent filth was the cause of many deaths from jail, ship, or typhus fever; and it is still the prolific source of many subtle diseases, especially in cities and large towns. (*b.*)

285. The term *malaria* literally means "bad air," but it is commonly applied to impure air which is capable of producing intermittent and remittent fevers, and to discomfort attended by more or less intermitting fever, or to certain forms of nervous disorders. The impurities consist of exhalations from vegetable matter in process of decay. The malarial poison emanates mainly at night from low and swampy regions, when the water in ponds and streams is stagnant, or where the vegetation is exposed to the heat of the sun.[1] (*a.*)

286. The *gases* which most often, either alone or in combination with suspended matters, make air impure

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[1] The deep upturning of the ground, as in the building of large sewers, and displacement of muddy soil to construct railroad beds, has produced malarial poison in localities where it had not been before. In a malarial region it is wise not to venture into the open air until at least a small amount of food has been taken. It is well also to keep in motion when out of doors.

The Eucalyptus tree and the sun-flower, on account of the power they possess of absorbing moisture by their roots, are valuable in drying the soil, and preventing malaria. Certain very malarious districts in Italy, near Rome, have been rendered healthy by the Eucalyptus tree.

and dangerous to life, are *carbonic acid*, *carbonic oxide*, *illuminating gas*, *sulphuretted hydrogen*, and *sewer gas*.

287. *Carbonic acid*, or carbonic anhydride, is the most constant gaseous impurity in the atmosphere. It is a heavy, invisible gas resulting from the combustion of all substances containing carbon, from the decay and putrefaction of all animal and vegetable substances, and from fermentation, and is given off during the respiration of animals. In nature it is ordinarily diffused throughout the atmosphere, and is absorbed by trees and plants. In them the gas is decomposed, the carbon being retained by the trees and plants for their growth, while the oxygen is returned to the atmosphere. That there is a compensating interchange of oxygen and carbonic acid between plants and animals is shown in a well-arranged aquarium. If the fishes give off the necessary amount of carbonic acid for the health of the plants, and the plants furnish enough oxygen for the fishes, there will be little need of frequently changing the water.

Notwithstanding the diffusive power of gases and the absorption of a large part of the carbonic acid by plants, it occasionally accumulates in such quantities in various places as to poison the atmosphere. When the moisture in the atmosphere is in excess, as in foggy weather, the amount of carbonic acid may increase from a little over three to eight volumes in 10,000. In damp weather, when the leaves are wet, its absorption by them is retarded, and it accumulates in the air. In manufacturing districts the accumulation is very great. When generated in low, confined places, such as cellars, beer vats, cesspools, caves, and mines, it may be retained for a time, partly by its weight and partly because it is generated faster than it can be diffused in the places in which it is generated, ren-

dering the air therein, especially in its lower stratum, dangerous to breathe and incapable of supporting combustion. The impurity may be tested by the going out of a lighted candle on its introduction into the impure air.[1] In the "Dog's Grotto," near Naples, and in various other places, carbonic acid is continually generated. Thus accumulated, it almost instantly kills animals and plants within the reach of its influence. (*a.*)

288. The amount of carbonic acid in the atmosphere can be quite readily determined, and its presence implies the presence also of other impurities. It is said that the odor of crowd poison becomes generally perceptible when the carbonic acid in the room exceeds six parts in 10,000 volumes of air. This is the amount mentioned by Dr. Parkes, the eminent sanitarian, as the "limit of permissible impurity," yet a much larger amount is often found in the air of houses, schools, etc. But though the odor of crowd poison be perceptible, carbonic acid itself has no odor. Usually, therefore, its subtle effects are upon us before any warning has been given. It accumulates in houses not well aired, from illuminating gas, lamps, furnaces, stoves, decaying vegetables and wood, and from our own breathing. (*a.*) The results of breathing it in any considerable quantity for a length of time are headache, dullness, giddiness, nausea, chilliness, and even unconsciousness and death. It is estimated that in general one per cent causes distress, four per cent renders air dangerous, while ten per cent destroys life.

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[1] Recently, in one of our large cities, in a house which had been shut up for the summer, several members of the family were taken sick soon after they reached home, and two died. The local health authorities, in the examination of the house, found that, in the unventilated cellar, a candle would not burn . . . "Choke damp" is the term given by miners to the carbonic acid generated in mines.

289. A much more poisonous gas than carbonic acid is *carbonic oxide* or *carbon protoxide*, for it not only robs the air of oxygen, but it destroys the blood globules, and its evil effects are not readily dissipated by fresh air, as is the case with carbonic acid. It is colorless, has but little, if any, odor, and is often found with carbonic acid. It results from imperfect combustion, and may pass through ill-fitting joints of furnaces and stoves, and, it is said, through the cast iron itself when it is very hot. This is more likely to happen when the supply of cold air is insufficient, or the escape of the products of combustion is largely prevented by smoke-pipes that are too small, or by the dampers. A stove or furnace should therefore be so large that it can warm the room without being itself very hot. Smoke-pipes should be large, and without dampers. More coal will thus be consumed, but the danger will be lessened.[1] Combined with sulphur compounds in the imperfect combustion of coal, carbonic oxide has the peculiarly disagreeable odor known as that of "stove gas"; but being odorless, when not combined, it may slowly insinuate itself into a room, and gradually undermine the health; whereas "stove gas" is irritating to the nostrils and throat, causing dryness, constriction, and a disagreeable smell and taste.[2]

290. *Marsh gas*,[3] so called because in hot weather it may be evolved from the putrefaction of vegetable matter in the mud at the bottom of stagnant pools, is the same

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[1] Some one has said, "It needs a philosopher to run a furnace properly."

[2] Recently, two ladies having sat in a room for an hour or two sewing, began to feel dizzy, and to tremble so persistenly, that sewing was dispensed with. While wondering what it meant, one became unconscious and the other nearly so. A gentleman entering the room perceived the odor of coal gas which had not been noticed by the ladies, and, on examination, found that the damper in the smoke-pipe had fallen so as to stop the escape of gas.

[3] Now termed *methyl hydride*.

as the "fire damp" of the coal mines. It constitutes a considerable portion of illuminating gas made by distilling coal. It is a compound of carbon and hydrogen, and is colorless, explosive, and poisonous.

291. *Illuminating gas*, as ordinarily delivered to the consumer, is mainly a mixture of marsh gas (about one-third), hydrogen, and carbon protoxide. The very best kind of illuminating gas poisons the air into which it may escape; but if the gas has not been thoroughly purified, it contains other and much more poisonous ingredients than those already named. The old, the very young, and all whose sense of smell is not acute, may be gradually poisoned by the slow escape of gas from a leaky gas pipe, without perceiving the odor of the gas.[1]

292. *Sulphuretted hydrogen*, or hydrogen sulphide, is a colorless gas, with the odor of putrefying eggs. It is very poisonous. When breathed in a pure state, it quickly proves fatal, destroying the blood globules, and is still dangerous even when diluted with atmospheric air.[2] In houses and other buildings it emanates from decomposing refuse in garbage receptacles, from cesspools and drains, and is a component of sewer gas.

293. *Sewer gas*,[3] especially of late years, has been held responsible for much of the sickness in houses connected with drains and sewers. "Sewer-gas poisoning," from

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[1] "To detect leaks in gas pipes, apply soap suds to the suspected leaky joint. The formation of bubbles will show an escape. This is safer than trying the joint with a lighted match. If the leak occur in the branch of a bracket or chandelier, it is repaired by soldering with plumber's fine solder; if it be a very small one, heat the piece first with a spirit lamp, and fill the aperture with cement." — *The Sanitarian.*

[2] $\frac{1}{800}$th part in the air is sufficient to kill a mouse.

[3] Probably a compound of carbonic acid, nitrogen, sulphuretted hydrogen, ammonium sulphide, and other substances, and containing disease germs.

defective plumbing of houses and insufficient airing of the sewers, undoubtedly exists, but the plumber is frequently blamed for sickness which is due to other causes. Still, odorless and poisonous sewer gas may escape into a room without its presence being known, or it may have a faint, sickly odor, or an odor like that of sulphuretted hydrogen, depending on the constituents of the gas, and may lower the vitality, thus making us susceptible to disease. Its presence should be excluded by well-ventilated sewers, and drains with tight joints; the pipes, closets, and basins should be so placed that, if a leak occurs, it will not imperil the health of the inmates of the house.[1]

294. Sometimes the air in houses is "devitalized," or robbed of its life-sustaining properties by other means than by poisonous gases; viz., by a mixture with the emanations from decaying lumber in cellars, from musty clothes stored in closets, from poisonous wall papers (*a.*), or decomposing paste between the layers of wall paper, from decomposing food in pantries, from tobacco smoke, etc. (*b.*) Sometimes houses built upon ground made by filling in depressions with dirt, ashes, and decaying animal and vegetable matter, as is too often the case, are permeated by deleterious gases, which find their way into them through cellar walls and floors, especially in winter, when the furnace and other fires in the houses create a

[1] A refrigerator connected with the sewer leads to the tainting of articles kept in it. Waste water pipes from roofs connecting with the sewer may convey sewer gas into the upper part of the house if these pipes open under windows, as is sometimes the case with mansard roofs. Occasionally, rats gnaw through lead pipes, and thus sewer gas escapes into houses; or the roots of trees penetrate faulty joints of drain pipe. Workmen have lost their lives in the opening of old cesspools, when the contents were stirred; though, before that operation, a candle would burn if lowered in the vat. During and after heavy rains, swollen rivers and streams often prevent sewage from escaping into them, and sewer gas "backs up" into houses, causing discomfort and sickness.

draught. In such cases the inmates suffer after the manner of those afflicted with malarial poison.[1]

295. It has been shown by Pettenkofer and others that bricks, ordinary mortar, cement, and sandstone are permeable by air and *moisture*.[2] Moisture also collects upon the walls of new houses, or those in damp situations, and is a source of disease. (*a.*) Mr. Chadwick states that houses newly built should not be occupied as dwellings until at least nine months after their completion, in order that the mortar, cement, etc., may become thoroughly dry. It is also a matter of great importance that the ground upon which houses are built should be thoroughly drained and dry, else the dampness will be promotive of consumption, rheumatism, and other severe affections.[3] Harmful gases

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[1] Authorities say that new ground should not be built upon until after three years.

[2] " A remarkable case in a London house has come to my knowledge, which gives a distinct proof of the much greater passage of gas through the walls in winter than summer. A small room occasionally used was noticed sometimes to have an unbearably bad smell. This was never noticed in summer, nor in winter, unless a fire was lighted in the room. The drainage was suspected and examined, but was found perfect ; yet here was this extraordinarily foul air making its way into the room whenever the interior was warm and the exterior cold. The cause was a dust bin built against one of the walls, and the filtration of the air through this and the house wall into the room." — *Air and its relations to life.* HARTLEY.

[3] Sand absorbs and retains but little water; but clayey soil, ten to twenty times as much as sand ; while rich earth absorbs and retains, it is said, forty or fifty times as much. Hard, rocky soils allow but little water to pass through them. An ideal building site is upon the side of a gently sloping hill (with a rocky and sandy soil), looking towards the south, not near a marsh or sluggish stream, and with good drinking water, and enough trees to protect it from the strong sunlight, and to absorb any excess of moisture there may be in the soil. On the other hand, very many trees, by affording too much shade, make the surroundings of a house damp, shut out sun-light, and assist in the production of malaria. It is of considerable importance that the trees should be of such kinds as to afford ample shade, and at the same time have no unpleasant odor. The trees which best meet these requirements, and that are pleasing to the eye, are the oak, elm, maple, tulip tree, ash, mulberry, linden, horse chestnut, and walnut.

also may be conveyed by even the best soil from leaky drains, sewers, gas pipes, and other sources of impurities. Pettenkofer mentions an instance of the death of one of the inmates of a house from illuminating gas from a leaky pipe, which had penetrated through the earth a distance of twenty feet into the basement.

296. Cowper says, "God made the country, and man made the town," and undoubtedly the air is very pure in those country districts where the inhabitants are not crowded together; where there are no factories or nuisances, no decomposing garbage, or other refuse; where the water supply is abundant, and no stagnant water exists; where the houses are well drained, and so placed that the sunlight enters the rooms; and where the dwellings and outhouses are at least one hundred feet apart. But where these conditions do not exist, the better portions of most towns and cities are preferable. Moreover, in the country there are not so apt to be health boards and sanitary associations to remedy evils.[1]

On the other hand, the numerous overcrowded and dirty tenement houses in the large cities are productive of very great mortality, and are often sources of danger to the better portions, being the starting-points of infectious diseases, low forms of fever, etc. Of late years "model tenement houses" have been erected in some of our cities, in which overcrowding and uncleanliness are prohibited by the owners. (*a*.)

297. The various impurities in the air, besides taking the place of oxygen, irritate the air passages and lungs, or

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[1] By the enlightened and active work of such bodies much good has been done. By proper drainage of low, swampy, or submerged lands, malarial fevers have been "crowded out," and the soil redeemed for corn and grain, or for building purposes. The health tracts and reports published by the above organizations contain much valuable information.

poison the blood directly by being absorbed by the organs of respiration. Where there is a moderate amount of impurities, not only is the blood rendered less pure, but the health of the tissue through which it passes is lowered, and the vital processes are depressed, and the individual becomes susceptible to contagion and infection. In a manner not yet fully comprehended, emanations from organic matter in process of putrefaction induce typhoid and typhus fevers, consumption, and other grave diseases.[1] (*a.*)

298. Many of the dangers arising from impure air may be obviated by *suitable ventilation* and by *purification by means of chemicals.*

By *suitable ventilation* is meant the free admixture of outdoor air with that of buildings and apartments, but so modified as to temperature and velocity of current, in its admission into rooms, that "draughts" are prevented.[1] Suitable ventilation should take place by night as well as by day. The airing of one room by introducing the confined air from another is not suitable ventilation; neither is it right to exclude from our sleeping-rooms the night air, of which so many live in fear. In fact, night air generally contains less carbonic acid than day air. (*a.*) But draughts of cold air, either by night or by day, are injurious to all, and especially to the feeble, the young, and the old. They lower the temperature of the body, and induce internal congestions. As some one has said, "a cold draught of air cuts like a knife."[2]

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[1] It has been shown that what will poison one person may have but little effect upon another less susceptible. There are some people who seem to "catch" everything, while others can expose themselves to impure air and sustain no apparent injury. In cities, noxious gases from factories, etc., sometimes poison susceptible people, and yet the poison may not be detected by the chemist or microscopist.

[2] "If cold wind reach you through a hole, go make your will and mind your soul." — *Old Spanish proverb.*

299. The velocity of the air current may be somewhat diminished, and the air may be warmed in cold weather by causing it to pass, before entering rooms, through openings in the outer and inner sashes of a double window, or by bringing it into contact with heated furnaces and stoves, through their air-chambers or flues, or by its passage through one or more layers of fine wire gauze, woollen, cotton, or linen cloth fitted in frames into the windows, or arranged as screens before the open windows. In very warm weather, the air may be cooled somewhat by suspending dampened cloths in the rooms, or by causing it to pass over ice in the lower apartments of a house, and then forcing it by fans or engines into the upper rooms.[1]

300. Appliances for the free passage of air into and out of rooms are known as *ventilators*.[2] These differ very much in structure and mode of action. The space below the decks of large ships, for instance, are ventilated by means of one or more huge "air shafts," having, at their upper extremities, wide-open mouths, so arranged that they automatically turn to or from the wind. Where there are two, the air enters one and ascends with the heated air from the cabins, etc., through the other, or it is forced in and out by means of large fans or engines. In a similar manner air is forced into tunnels, caissons, etc. In mines, ventilation is effected by building fires at the bottom of one shaft, thus sucking in the outer air through another shaft, and expelling the impure air through the shaft at the bottom of which the fire is built.[3]

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[1] The late President Garfield's room was made comfortable in this way during his last illness.

[2] The terms *natural* and *artificial* ventilation are often used. The first refers to that obtained by open fire-places, doors, and windows; the last, to special appliances.

[3] Sometimes a single partitioned shaft is made to accomplish the same result, the fire being built under one of the partitions in the shaft.

301. In dwelling-houses and other buildings, an outward draught of air is created in smoke pipes and chimneys at all times, but especially when fires are burning in the grates, stoves, and furnaces. Hence, in very cold weather, and if the wind is blowing very hard, sufficient air for ventilating purposes may be "sucked in" through air-chambers and flues of furnaces, or by the sides of window-sashes; but, ordinarily, it is necessary to admit air in larger quantity. (*a.*) How to do this without injurious draughts is a difficult problem in some instances. It is sometimes advised that a room having but one window be ventilated by opening the window either at the top or at the top and bottom, and by opening a door into a hall or passageway; or, if there are two windows, opening one at the top and the other at the bottom, while the door may or may not be shut. Such ventilation is attended with draughts.

A safer plan is to admit air through wire gauze, cotton cloth, etc., as before described, or between the sashes of one or more windows, where the sashes meet, by placing under the lower ones boards occupying the whole width of the sash, and from three to six or more inches wide, depending upon the size of the rooms to be ventilated and the velocity of the currents of air.[1] The air thus passing in is not deflected directly downwards upon the occupants of the room. A current is created by the impure air escaping through open fire-places, or openings in the chimney.[2]

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[1] A simple and effectual arrangement is that of Dr. Keen; viz., fastening "with tacks or loops a piece of paper or cloth across the lower ten or twelve inches of the window-frame, and then raising the lower sash more or less, according to the weather." It will probably occur to the reader that the cloth so placed may be suitably ornamented on one or both sides.

[2] Fire-places should not be entirely closed; neither is it well to have them so large and open that a great draught is created, thereby drawing the air

302. Arnott's automatic chimney-place ventilator,[1] or the revolving metal wheels inserted into window panes are simple and effective ventilators. Air may also be admitted through small diagonal openings in the window-sashes. In factories, institutions, schools, public vehicles, and other places where the ventilation is to be provided for many persons, it should be automatic; for, if regulated by the varied judgment of the numerous inmates, it will prove ineffective. (*a.*)

303. All houses having furnaces should have roomy air-boxes leading from the outdoor air to the air-chambers of the furnaces. If possible, the air should be drawn from above the street level, in order to be comparatively free from dust and other suspended matters.[2]

304. To keep the air in a proper condition, especially where rooms are small and there are many inmates, is a difficult matter; for, the smaller the room, and the larger the number of inmates, the swifter must be the currents of ventilating air, and the greater the danger from draughts. Hence, estimates of the necessary amount of *air and cubic space* which each person requires under various circumstances have been made by sanitarians as guides to proper ventilation.

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too strongly out of the room and too much heat up the chimney. Such fire-places must needs consume a large quantity of fuel in order to radiate sufficient heat to be equally diffused throughout the room. The open fire-place stove, or "fire on the hearth," and the Franklin stove and its modification, with their outer jackets or envelopes, which receive and warm cold air as it passes through them into rooms, are preferable to ordinary stoves, which throw out dry and superheated air.

[1] A valve so arranged as to open with upward currents of air into the chimney, and to close with the downward currents.

[2] It is shameful to have to state that, at the present day, houses are sometimes built without air-boxes, or with boxes that open into cellars instead of out of doors. Occasionally, foul air is sucked into apartments from cellars through defective air-boxes, thereby causing much sickness.

305. Dr. Parkes claims that a complete change of air three or four times per hour is all that can generally be borne without the sensation of draught. If the cubic space allowed to each person is less than 300 cubic feet, and there is no adequate ventilation, the danger to life is great. By most authorities, 600 cubic feet of space are considered as ordinarily necessary for each individual in a room of ordinary size. If the arrangements for ventilating are very poor, from 750 to 1,000 feet are required. In hospitals and factories, especially where the sources of impurities are many, from 2,000 to 3,000 cubic feet of air space are said to be necessary. (*a.*)

306. Very often disagreeable odors may be removed from the air of a place, or the poison of gases lessened by the admission of an abundance of fresh air, which is far superior to smouldering paper, burning coffee, cologne water, and other things commonly used as purifiers, but which act only as *deodorizers*, simply replacing one odor with another that is stronger.

It often becomes necessary, for the preservation of health, to remove impurities or bad odors in the atmosphere by the use of chemicals. These may be either in a solid, liquid, or gaseous form, and are known as *disinfectants*. Some of these act as *antiseptics*, from the power they possess of arresting putrefaction in animal and vegetable matter, and of preventing the development of disease germs. Belonging to this class are some metallic salts, especially the sulphates and chlorides of zinc and iron, together with chlorine gas, carbolic acid, and thymol.[1]

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[1] One part of thymol to 1,000 of water checks alcoholic and greatly retards lactic fermentation and putrefactive decompositions. It has the agreeable odor of thyme, is less poisonous than carbolic acid, and is ten times more powerful.

307. Some substances act as *absorbents* of gaseous emanations from decomposing bodies. Charcoal and lime are of this class. The coating of walls, especially of cellars, with lime wash is a useful method of sweetening the atmosphere, and should be frequently repeated.

308. A third class of disinfectants acts *chemically* upon the results of decay, and thus renders them harmless. Chlorine (in the form of chloride of lime, or a solution of chlorinated soda), nitrate of lead, and sulphurous acid gas from burning sulphur, belong to this class; they rid the air of sulphuretted hydrogen, and destroy bacteria. Cold arrests putrefaction, but does not destroy germs. Heat 200° to 250° F. is a powerful disinfectant, and one capable of destroying all "disease germs." (*a.*)

309. *Light.* In addition to an abundance of air of the right kind, animals, like vegetables, need sunlight. Without this the blood is impoverished, the skin and muscles grow pale, and vital energy is diminished. (*a.*) Secluded from the light, human beings become pale and sickly, just as plants do in cellars; and, like plants, will grow stronger and healthier on removal into the light.

During the prevalence of epidemics in some of our Southern cities, it was noticed that there was more sickness on the shady than on the sunny side of the streets. Houses should be so constructed that the sun can shine into the various rooms at some time within each twenty-four hours. But just as we have found to be the case with the other vital requisities of man, so there may be an *excess of light*, and of its accompanying heat. Too great exposure, in warm weather, to the direct rays of the sun may induce sunstroke. Even in the frigid zone, the glare of the light on the snowy landscape is attended with danger to the sight, — a danger which is also incurred by those

who have the sun's rays reflected upon them from white sand and other reflecting objects.[1]

QUESTIONS.

1. What is the thickness of the atmosphere? What its pressure and the importance of it? Illustrate.
2. What are the essential ingredients of the atmosphere?
3. What is to be said of the relative proportions and uses of nitrogen and oxygen?
4. What of ozone? What other ingredients are found in air?
5. Of what does the dust in the air consist, and from what sources does it come?
6. Who should protect themselves from its evil effects, and how?
7. What is to be said of "disease germs" and of their development?
8. What of the organic nitrogenous matters thrown off by the lungs and their effects?
9. To what is the term *malaria* applied, and what are some of the causes of malaria?
10. What gases corrupt the atmosphere, and which one is constantly present therein?
11. From whence does the atmosphere derive its carbonic acid or carbonic anhydride, and why should so poisonous a gas be an *essential* ingredient of the atmosphere?
12. When and where is it apt to be in excess, and what are the effects?
13. What is to be said of carbonic oxide? of marsh gas? of illuminating gas? of sulphuretted hydrogen? of sewer gas?
14. What other emanations than the above gases *devitalize* the air?
15. What is to be said of damp building-sites and of leaky drains and gas pipes?
16. State the relative advantages of city and country life.
17. What are the effects of an impure atmosphere upon the health, and how may they be obviated? Illustrate as to ventilation; also as to the use of chemicals.
18. What effects follow a deprivation of light? What its excess?

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[1] "To obviate the dangers of an excess of light, nature carpets the earth with *green*, and either vaults the heavens with *blue*, or draws over them her *gray* curtain of cloud, and at proper intervals spreads over us the *black* pall of night, bringing with it refreshment and rest."

ANALYSIS OF THE THIRTEENTH CHAPTER.

ATMOSPHERIC AIR.

- I. PRESSURE.
- II. ESSENTIAL COMPOSITION
  - Oxygen.
  - Nitrogen.
  - Carbonic acid.
  - Watery vapor.
- III. IRREGULAR COMPOSITION
  - Abnormal intermixture of essential components.
  - Intermixture of non-essential components
    - Suspended matters
      - Dust.
      - Disease germs.
    - Gaseous matters
      - Carbonic oxide.
      - Sulphuretted hydrogen.
      - Illuminating gas.
      - Sewer gas, etc.
- IV. EFFECTS OF IMPURE AIR.
- V. PURIFICATION
  - Ventilation.
  - Disinfection.

LIGHT.

- I. EFFECTS OF A SUFFICIENT AMOUNT.
- II. EFFECTS OF AN EXCESS.

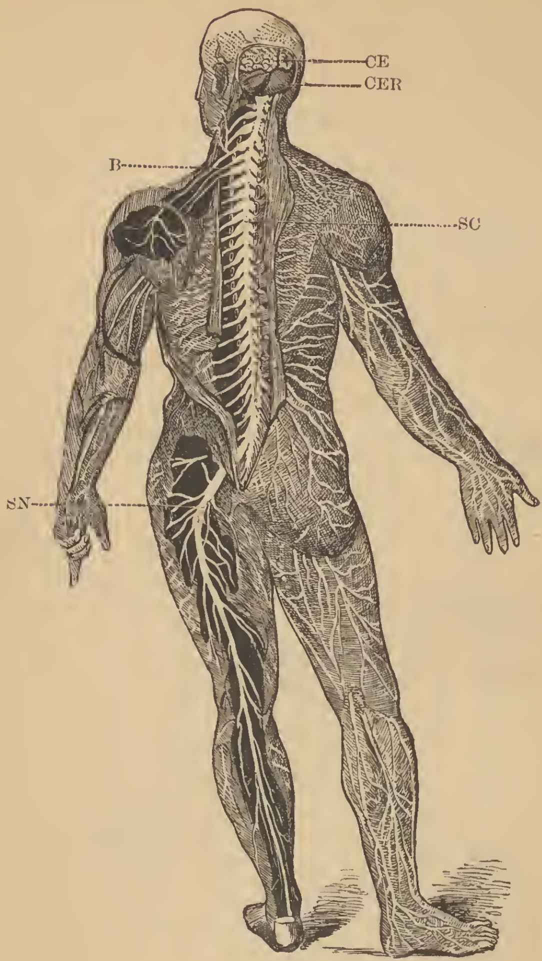

Fig. 66.

Posterior view of the spinal cord,—a portion of the cerebrum and cerebellum, and some of the nerves of the cerebro-spinal system. On the left side of the body some of the tissues are removed to show the deeper nerves, while the right side shows certain superficial ones.—CE, cerebrum; CER, cerebellum; B, nerves distributed to the arm; SC, spinal cord; SN, sciatic nerve.

CHAPTER XIV.

THE NERVOUS SYSTEM.

310. Some of the processes already studied, viz., Digestion, Circulation, Absorption, and Respiration, are common to both animals and vegetables; but the processes by which consciousness, will-power, voluntary motion, sight, hearing, etc., are accomplished, are, as far as at present known, peculiar to animals. One animal is superior to another in proportion to the number and development of these functions. In man, their number is the greatest, and their development the highest, so that man maintains supremacy over all other forms of creation.

311. In health, all the organs of the human body possess a peculiar property known as *irritability*,[1] which enables each one to perform its function at the right time in the right way, and in accord with the functions of other organs. Thus, the gastric juice is secreted whenever any substance is introduced into the stomach, and the number of the pulsations of the heart bears a definite relation to the frequency of the respiratory movements. This irritability or normal excitability of tissues, together with the performance of all vital functions, is made possible by the *nervous system*, through which all impressions are received, and by means of which motion, sensation, thought,

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[1] "Irritability (*irrito*, I provoke). In Physiology, this word signifies the power of responding to a stimulus, as exemplified by the contractility of muscular tissue. In medicine, irritability implies an undue excitability of an organ or tissue, from disease or disorder, such as of the brain, spinal cord, stomach, eye, or bladder." — *Dictionary of Medicine*. QUAIN.

etc., are produced. This system regulates *all* the movements of the body, both voluntary and involuntary, and *all* the processes, and harmonizes the functions of the various organs.

312. The healthy human body may be likened to a well-ordered community, in which various industries are carried on, each in a different way, but all conducive to the general good, and controlled by one official head and his subordinates. The various organs of the body are connected with the centre of operations, the brain, by means of nerves, which are like so many electric wires running to and from the seat of government of the community. By this arrangement, notice of any disturbance is immediately communicated to "headquarters," and the remedy promptly furnished. The importance of the nervous system with its harmonizing influence is best appreciated when we witness the results of disturbances therein, such as irregular action of the muscles of the extremities in spasms and cramps, fluttering of the heart, convulsions, etc.

313. *The general arrangement and structure of the nervous system* is as follows: —

Owing to the difference in location and function of its various parts, there are two divisions of the nervous system; viz., the *cerebro-spinal nervous system*, and the *sympathetic* or *ganglionic nervous system*.[1] The first-named division includes all that portion of the nervous system contained within the cranial cavity and the spinal canal;

[1] At one time it was believed that one part of the body became diseased through "sympathy" with another part. As the second of the above-named divisions of the nervous system is largely responsible for the spread of disorder and disease, it has been called "sympathetic" in deference to the old belief. The term *ganglionic* refers to the fact that this division of the nervous system is composed largely of ganglia or masses of gray nervous matter.

viz., the brain and the spinal cord, together with the nerves which branch off from each. This system presides over the functions of animal life as volition, sensation, etc.

The second-named division, or the *sympathetic system*, includes all that portion of the nervous system located, in the main, in the thoracic, abdominal, and pelvic cavities, and which is distributed to the internal organs. Its special function is the regulation of involuntary processes, as growth and nutrition.

314. The nervous system, whether simple in arrangement, as in the star-fish, or more complicated, as in the higher animals and man, consists of *two* different kinds of tissue, the one *white* and the other *gray*. These differ from each other not only in color, but in structure and mode of action. The *white* matter constitutes the bulk of the nervous tissue, and is in large quantity on the exterior of the spinal cord and in the interior and lower surface of the brain. To the unaided eye, it seems to be but a mass of white, semi-solid material. In reality, it is mingled with delicate and transparent connective tissue, so as to form slender threads, which, for the most part, lie parallel to each other. They are termed *nervous filaments*, or nerve fibres. Nervous filaments are cylindrical and of very small diameter.[1] Running longitudinally through the centre of each is a flattened, semi-transparent band of gray color, known as the "axis cylinder," which is the essential element of the nerve fibre. Through it the nerve current is transmitted. The filaments are distributed to all the tissues, but in a varying degree. As they emerge from the tissues, they come together to form bundles. These in turn unite with other similar bun-

[1] They vary in size from $\frac{1}{2000}$ of an inch in nerves to $\frac{1}{10000}$ of an inch in the brain.

dles, and the bundles, which are large enough to be seen with the naked eye, are called *nerves.*[1]

315. *Nerves* are of various sizes,[2] and are invested with a sheath termed the *neurilemma.* Each bundle of filaments is similarly sheathed, but with more delicate connective tissue. In all of the sheaths are capillary

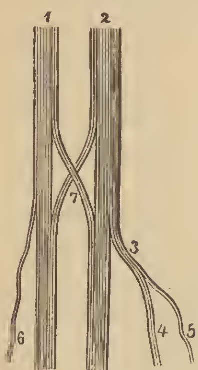

Fig. 67. (LEIDY.)

Mode of branching of nerves.—1, 2, two bundles of nerve fibres; 3, a branch of three fibres; 4, branch of two fibres; 5, 6, branches of single fibres; 7, decussation between two nerves.

Fig. 68. (GRAY.)

Nerve cells from spinal cord. Magnified.

blood-vessels. Though the nerve fibres are thus closely connected together, each filament acts independently of every other. When nerves are said therefore either to

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[1] From the Greek *neuron.* The structure of a nerve is similar to that of a string or cable, the individual threads or wires being united into strands, and the strands into the string or cable itself. The nervous filaments are not twisted as the threads and wires generally are in strings and cables; but, like the wires in the largest cables of suspension bridges, they are for the most part parallel to each other, each being separate from its beginning to its end.

[2] The sciatic nerves, located in the back part of the thighs, are the largest in the body, viz., as large in circumference as the tip of the little finger of the average adult. That painful affection known as "sciatica" results from some irritation of the sciatic nerve.

"branch," or to "decussate" (*i.e.*, cross each other), it is some of the filaments of which the nerves are composed which leave the nerves and branch off or cross each other. (Fig. 67.) *The sole function of nerves is to transmit nervous force and impressions.*

316. The *gray* matter of the nervous system is of an ashen-gray color, and constitutes the external or convoluted layer of the brain, various deposits in the centre of the brain and the centre of the spinal cord, and the masses called *ganglia*[1] in the different parts of the body. Under the microscope, this substance is seen to consist mainly of cells, known as *nerve cells*, which are intermingled with nervous filaments and connective tissue. These cells vary in form and also in size.[2] Some of them have long projections, which it is believed, for the most part, connect directly with the filaments of the nerves. Every collection of gray matter, whatever its situation or size, is a *nerve centre*. Its function is to *receive nervous impressions* and to *originate and impart nervous force*, which are conveyed to and from the nerve centres by means of nerves. (*a*.)

317. *The brain* is the great mass of nerve tissue which occupies the cranial cavity. It consists of three parts; viz.: first, the *cerebrum*, or brain proper, which is the largest, and occupies the upper, front, middle, and back portion of the cranial cavity; next, the *cerebellum*, or "little brain," which about fills the lower and back portion of the cavity; and, thirdly, the *medulla oblongata*,[3] which is the smallest part, and is the broadened commencement of the spinal cord, lying below and in front of the cerebellum. (Fig. 69.)

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[1] From the Greek word *ganglion*, meaning a knot.

[2] Viz., from $\frac{1}{1000}$ to $\frac{1}{300}$ of an inch.

[3] Sometimes called the "oblong cord."

318. Both the brain and the spinal cord are divided by a longitudinal furrow into two portions, right and left. Both, being soft and easily pressed out of shape, are protected from the dangers of shock, and of friction against their strong, bony encasements, by coverings called *meninges* or *membranes*, by connective tissue, and by fluid between certain of the membranes. The outermost membrane, the

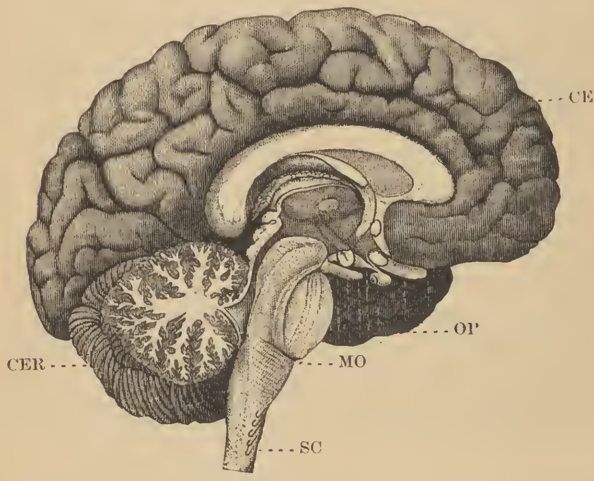

Fig. 69.
Vertical section of brain.—CE, cerebrum, left hemisphere; CER, cerebellum, left portion; MO, medulla oblongata; SC, spinal cord; OP, optic nerve.

dura mater,[1] is white, thick, and very resisting. It lines the cranial cavity and the spinal canal, and has various shelf-like expansions in the former for the support of different portions of the brain.[2] Underneath the dura mater is the *arachnoid*,[3] a closed sac of serous membrane (similar in

[1] "'Hard mother'; called *dura* because of its great resistance, and *mater* because it was believed to give rise to every membrane of the body."—*Med. Dict.* DUNGLESON.

[2] A sickle-like projection inward, in the longitudinal fissure of the brain, a horizontal partition between cerebrum and cerebellum, etc.

[3] A name originally applied to delicate membranes resembling spiders' webs.

structure to the pericardial and pleural sacs), which secretes an albuminous, lubricating fluid. The very considerable protection and freedom of movement afforded to the brain and spinal cord by this sac, with its soft and yielding liquid contents, is quite evident. Closely adherent to the brain and spinal cord, and dipping down into the furrows, is the third and last covering, the *pia mater*,[1] which is not in reality a membrane, but a fine net-work of capillary blood-vessels, in the meshes of a delicate connective tissue. Through these capillaries, and the large blood-vessels which enter at its base, the brain is *abundantly supplied with blood.* Usually, it has not more than *one-fortieth* of the weight of the body, yet it receives about *one-fifth* of the whole volume of the blood. This large proportion of blood indicates that the brain is intended for active work, but, as in other organs, its working capacity is dependent not only upon the quantity, but also upon the quality, of the blood which it receives.

319. The *size* and *weight* of the brain depend somewhat on the size of the individual, but they also bear considerable relation to his intellectual capacity. (*a.*) In the lower animals, the cerebellum and the ganglia at the base of the brain are the largest, but in the higher animals and man, the cerebrum, as a rule, increases in size in proportion to the degree of intelligence. In man, the size is very much greater in proportion to that of the entire body than in any of the lower animals. The quality of the brain material is also undoubtedly a matter of importance, for the brains of some very intelligent persons have been found to be comparatively small.

320. The brain proper, or *cerebrum*, is rounded upon its upper and lateral surfaces, where its shape conforms

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[1] "Delicate mother."

to that of the skull, while its base or lower surface is more flattened, and rests anteriorly upon the floor of the cranial cavity, and posteriorly upon a membranous expansion of the dura mater separating it from the cerebellum. The longitudinal fissure, before referred to, divides the cerebrum into two nearly equal parts, called *hemispheres*, which, however, are connected towards their lower portions by a white, nervous substance, called a *commissure*.[1]

321. Both hemispheres are everywhere marked on their outer surfaces with irregular grooves and ridges, and are covered by gray matter. The undulations thus formed are termed *convolutions*. This convoluted arrangement provides, in a small space, a large amount of gray matter, the source of nervous power. The convolutions, in proportion to their number and well-marked character, indicate the degree of intelligence in animals and man. In young children, especially before the age of seven years, when the brain is very soft and imperfectly developed, and the mental powers are not strong, the convolutions are not well marked. Such is also the case in the lower animals and in the uncivilized races of mankind.[2] The *white matter of the hemispheres* is large in amount, and consists of nerve fibres prolonged from various tissues and organs of the body. These fibres terminate in the gray matter of the convolutions and in the ganglia of the brain.[3]

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[1] That is, "point of union of two parts."

[2] "There are exceptions, however, as in the whale and elephant, in which the convolutions are exceedingly intricate and beautiful. The particular arrangement of the fissures and convolutions differ as the brain ascends through the half apes, the apes, and man."

[3] In the cerebrum are many curious and interesting anatomical arrangements; viz., cavities, ventricles or water beds, passage ways, curtains, etc., which, though important to the anatomist and physician, are too intricate and complex to be here described.

322. Notwithstanding the complicated structure of the cerebrum, and the fact of their being two hemispheres, it is a *single organ*, as far as the intellect is concerned, but a *double one* with relation to the two sides of the body. Impressions from either side of the body, such as result, for example, from injuries, will be appreciated through the hemisphere on the opposite side, owing to the decussation, in the course of the spinal cord, of nerve filaments which convey sensations. The bursting of one or more blood-vessels (*i.e.*, apoplexy), or the stoppage of a vessel by a blood clot, on one side of the cerebrum, injures the nervous tissue and produces complete or partial paralysis, but only upon the opposite side of the body, owing to the decussation in the medulla oblongata of nerve filaments that convey motor impulses.

323. The *cerebrum* is the *organ of the mind*. It is that part of the nervous system through which the intellectual and moral powers or faculties act.[1] These faculties, rightly used, make man the "noblest work of God"; for his is the highest organism, and "the one which best adapts itself to its environments." Of these faculties we shall speak more particularly of but one, — the memory.

324. *Memory*, or *retentiveness*, as it is sometimes called, is that faculty by which we retain in our minds the impressions received therein.[2] A good memory is essential to a

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[1] Facts in regard to the functions of the nervous system are ascertained from the study of the lower animals, and by experiments made upon them, and also by studying the results of disease and injury in the human being. It is a curious fact that the cerebral substance is not sensitive, but can be cut or torn without pain resulting. In general, loss of cerebral substance by disease or severe injury results in impaired memory, tardy, inaccurate, and feeble connection of ideas, irritability of temper, easily-excited emotional manifestations, etc.

[2] All of the higher forms of animal life have memory. The elephant, it is said, will remember for months persons who attempt to injure him. The

healthy development of the intellect.[1] It is the function of a good memory not only to retain facts, but to produce them when wanted; not merely to store up knowledge, but to use it at the proper time and in the proper way. Facts are not isolated from each other; they have their connections and relations. When systematized and arranged, they teach us all that we can know of philosophy or science. To memorize dry catalogues of facts is *to refuse to think*, and is an abnormal use of the memory, which should never be permitted by the true educator of the mental powers. (*a*.) It is the connection between facts, and the perception of that connection by the logical faculties, which enables memory to retain its grasp upon them; and when that connection is not perceived, memory becomes a rope of sand.[2]

325. Of the success of the various attempts which have been made, from time to time, to locate the organs of the mental faculties in various parts of the cerebrum, it is perhaps too early to speak with scientific accuracy, though much has been accomplished within the last few years towards localizing the centres of motion, sensa

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horse does not forget kind treatment, and the dog, more demonstrative than either, will readily approach and caress his kind master, while he slinks away from his persecutor.

[1] There is a common impression that a weakened memory is among the first evidences of a diseased brain; whereas, in many forms of insanity the memory is normal, or even acute.

[2] "We are apt to be carried away with a vague notion that there is no limit to acquirement, except our defect of application or some other curable weakness of our own. There are, however, very manifest limits. We are all blockheads in something; some of us fail in mechanical aptitude, some in music, some in languages, some in science; memory in one of these lines of incapacity is a rope of sand; there must be in each case a deficiency of cerebral substance for that class of connections." — *Mind and Body*. BAIN.

Curious instances are narrated, and in fact occur in the experience of everyone, which seem to show the exercise of considerable reasoning power in brutes.

tion, sight, smell, etc.[1] "It is known that irritation of the surface of the brain by electricity will evoke movements of the muscles. And it has been determined by experiments upon the lower animals what portions of the brain need to be thus irritated, in order to produce muscular movements in any particular part of the body. It has been further shown by similar experiments, and corroborated by studies of diseased conditions of the brain, that the removal of certain parts of the brain, respectively, or injury to them, will produce blindness, deafness, or lack of smell, etc., as the case may be."[2] Whether the organs of the faculties may or may not be localized, the brain is, nevertheless, a part of the body, and subject to the same laws. In consequence, the exercise of the faculties wears out cerebral substance, which must be restored by obeying hygienic laws. If one faculty or set of faculties has been overtaxed, rest and the use of other faculties instead are demanded. The most vigorous intellect is generally found in the most evenly developed body; and so closely are mind and body related, that if the health of one fails, that of the other also is likely to be impaired.

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[1] "The faculty of articulate language appears to reside in the third or inferior frontal convolution of the left side, which convolution would contain both the centre for the memory of words, and the centre for the coördination or combination of the movements of speech." —*Tablets of Physiology*. COOKE.

The fact of the above localization is generally accepted by physiologists, but recent investigations seem to show that the centres for motion, sensation, and the mental faculties are not as isolated as has been hitherto supposed, but that they are more diffused and shade off into each other. Thus a wonderful provision is made for emergencies. If the very heart of an ideal centre or area be injured, there will be oftentimes sufficient nervous tissue remaining to perform the work in a more or less perfect manner.

[2] A dog, deprived of smell, by injury to a certain portion of the brain, will not touch a piece of meat temptingly put before him; but, if the piece is put into his mouth, the sense of taste enables him to recognize it, and then he devours it.

326. The *cerebellum*, like the cerebrum, is covered by gray or ash-colored matter, which dips into the white substance. There are no convolutions, but in their place nearly parallel ridges of irregular depth.[1] The cerebellum is well protected by its membranes and by thick, bony walls. Like the cerebrum, it is without feeling. Its function is the *coördination* or harmonious regulation of the movements of the voluntary muscles. The necessity of its directing power is made manifest whenever that power is interfered with, as is shown in the unsteady gait of the drunkard, or where there is some injury or disease of the cerebellum.

327. The third division of the brain, or *medulla oblongata*, is the upper enlarged end of the spinal cord, or "oblong spine," as the name implies. It resembles the spinal cord in the arrangement of the white and gray matter. From its interior and from the under surface of the cerebrum arise what are known as the *cranial nerves*, which emerge from the cranial cavity through openings in the base of the skull, and are distributed to various parts of the head and neck, to the organs of special sense, and to some of the thoracic and abdominal organs. In the front portion of the medulla oblongata the motor nerve fibres cross or "decussate" in their passage to and from the brain. But a still more essential feature of the medulla oblongata is that, in its posterior and lowermost portion, nerves have their origin which control indirectly the function of respiration. Important portions of the cerebrum or cerebellum may be almost destroyed by disease or injury, and in consequence the various mental faculties may be rendered almost useless, and sensation in general and the

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[1] From the peculiar branching appearance of the gray matter in a perpendicular section of the cerebellum, it is called *arbor vitae*, or tree of life.

power of voluntary motion may be lost; yet, if the points of origin of these nerves — vital knots or points, as they are sometimes called — are intact, life remains. If injured, breathing is impaired; if destroyed, death necessa-

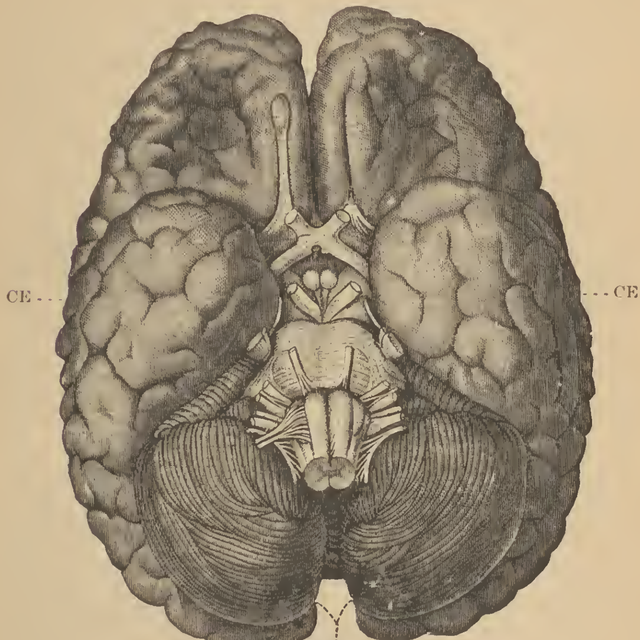

Fig. 70.

The lower surface or base of the brain. — CE, cerebrum, right and left hemispheres; CER, cerebellum, right and left portions. Passing from one hemisphere to another is a white, broad, transverse band of fibres, like a bridge. This is the "Pons Varolii" (bridge of Varolius), and is a bond of union between the various segments of the brain. Underlying it is the upper portion of the medulla oblongata. The cranial nerves are shown branching out from under the front and middle portions of the hemispheres, and from the sides of the medulla oblongata.

rily results. Hence, the protection of the medulla is an object of primary importance. It is accordingly so deeply buried within the skull that it is seldom injured by blows and falls. Apoplexy in this part of the brain is also of

rare occurrence. Sometimes, however, in fracture of the spinal column near its articulation with the skull, particles of bone are driven into the medulla oblongata, causing instant death.[1]

328. The *spinal cord*, or spinal marrow, is continuous with the medulla oblongata, and, extending downwards, fills the cavity of the spinal canal in the vertebral column. It is a somewhat cylindrical mass of nerve tissue, and is fissured in front and behind. It becomes enlarged in the cervical and lumbar regions, at the points where the nerves supplying the upper and lower extremities are given off, and its lower end sends out prolongations through the sacrum, which, from their fancied resemblance to the hairs of a horse's tail, are called the *cauda equina*. It is composed of a central mass of gray matter, extending nearly its entire length, and surrounded by longitudinal bundles of nerve filaments, the whole being enclosed by the membranes (the dura mater, etc.) before described. The gray matter of the spinal cord, as shown in a transverse section, is arranged somewhat like a double crescent united by a band of gray matter. The respective extremities of these united crescents are called *anterior* and *posterior horns*. Opposite them, at regular intervals, filaments of the spinal nerves emerge from the cord. The white matter of the cord lying between the posterior horns and posterior fissure, constitutes the right and left posterior columns; and that between the posterior horns and anterior horns, the right and left lateral columns; that between

[1] Instantaneous death results also from a "broken neck," or from injury to the medulla oblongata without the neck being broken, as when the atlas is dislocated by the striking of the head upon the bed of a stream in diving from a height into shallow water, a proceeding always attended with danger. Occasionally animals fall dead from sudden injury to the vital knot. For instance, a clumsy shanghai rooster, in full pursuit of another, died suddenly from falling over a wooden pail, striking, in the fall, the back of his head.

the anterior horns and anterior fissure, the anterior columns.[1] These columns are connected with filaments of the spinal nerves, and thus the spinal cord is a conducting medium as well as a nerve centre. The posterior columns of the spinal cord convey sensory impressions to the cerebrum, and the antero-lateral columns convey motor impulses from the cerebrum. Injury to the spinal cord will produce paralysis of the parts below, through the spinal nerves. Such injuries generally occur when one or more of the vertebrae are broken by falls, blows, etc. When the spinal column is fractured at its middle, the lower extremities are paralyzed, the upper remaining unaffected.[2] When the injury is in the neck region, the upper extremities are also paralyzed, for the cord is damaged above the point at which the nerves distributed to them are given off. Sometimes injuries to the spine result in loss of power or sensation only; but, if severe, the parts below are deprived of both sensation and voluntary motion.

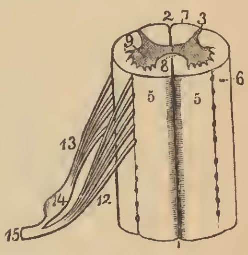

Fig. 71.

Segment of the spinal cord.—1, anterior fissure; 2, posterior fissure; 3, posterior horns; 5, anterior column; 6, lateral column; 7, posterior column; 8, anterior commissure; 9, anterior horns of gray matter; 12, anterior root of a spinal nerve; 13, posterior root; 14, ganglion on posterior root; 15, spinal nerve formed by the union of the two roots.

329. The *spinal nerves* consist of thirty-one symmetrical pairs of nerves, which are connected with the spinal cord by so-called *roots*. Each nerve has an anterior and a

1 "Called columns because the nerve fibres composing them run for the most part in a longitudinal direction." Recent investigations seem to show that the columns are more intricate than has been believed, and admit of further division and subdivision.

2 Such paralysis is called *paraplegia*, while that which results in one side of the body from injury to one cerebral hemisphere is known as *hemplegia*.

posterior root. The posterior roots (upon each of which is a ganglion), with their respective nerves, are known as *sensory roots* and *nerves*, because they convey sensations; while the anterior roots, with their nerves, are the *motor roots* and *nerves*, because they convey motor impulses. Just beyond or outside of their junction with their respective roots, the motor and sensitive filaments are enclosed in the same sheath, but their functions always remain distinct. The spinal nerves are mainly distributed to the skin and muscles upon the corresponding sides of the body, and convey nervous force and impressions to the trunk and the extremities.

330. *Sensory impressions*, such as the perception of heat and cold, or of the size, consistency, location, and character of objects, are conveyed by the sensory nerve fibres of the skin and other parts of the body to the sensory roots of spinal nerves, and by them to the gray matter of the cord, or to the posterior columns of the opposite side of the spinal cord, to be transmitted by them to the cerebrum.[1] *We become conscious of sensations only when they are thus carried to the brain.* In proportion, however, as an object becomes painful, whether by reason of its great heat, pressure, or otherwise, the sensory nerves lose their power of enabling us to perceive the ordinary properties of the object, and we become aware only of suffering. An injury to a sensitive nerve in any part of its course is not felt at the point of injury, but where impressions are ordinarily felt, — at the *terminal points of the nerve filaments.* This fact explains why it is, when the ulnar nerve, or "funny bone," at the elbow is struck sharply, numbness or pain is referred to the outer side of

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[1] Sensory nerves are sometimes called *afferent* nerves; and motor nerves, the *efferent* nerves.

the hand and the little finger, which parts are supplied by this nerve. Oftentimes, after a limb has been amputated, the patient claims that he suffers pain in the part removed, or that his toes or fingers, as the case may be, are being tampered with. The cause of this distress is generally found to be some irritation of the nerve in the wound. When the force of the nervous current is diminished in sensory and motor nerves by pressure, as when one leg is

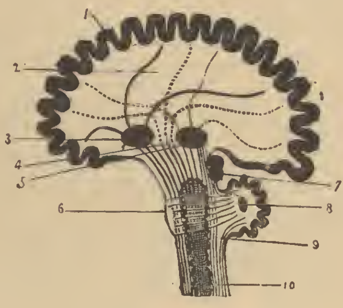

Fig. 72. (Westbrook.)

A diagram to represent the passage of the nerve fibres from the spinal cord upward to the different parts of the brain, and some of the more important ganglionic masses with which they are associated.—1. The gray matter of the cerebral convolutions. 2. The white matter of the interior of the cerebrum, through which the fibres pass on their way to the convolutions. 3. The *corpus striatum*, or anterior basal ganglion; the fibres passing through it run in three principal directions: viz., to the anterior, middle, and posterior regions of the cerebrum; they are represented by the three *continuous lines*. 4. The space between the two basal ganglia, through which fibres pass directly from below upwards; these fibres appear in the cerebrum as *broken lines*, running toward the three principal regions. 5. The *optic thalamus*, or posterior basal ganglion, with fibres (represented by *dotted lines*) traversing it on their way from below upward. 6. The *pons Varolii*, made up of horizontal fibres which cross from one side of the cerebellum to the other. 7. *Corpora quadrigemina*, from which the optic nerves, in part, take their origin. 8. The *cerebellum*, with a ganglionic mass in its interior, and fibres passing into it from the brain above and *medulla oblongata* below (9). 10. The dark convoluted line indicates the ganglionic matter of the spinal cord reaching up into the *medulla oblongata* and *pons Varolii*.

kept crossed over the other, in a constrained position for a length of time, or the arm is lain upon in sleep, temporary numbness of the limb and loss of motion results, and the part is said to be asleep. Attempts to move either arm or leg under the circumstances will, for a moment or two, prove futile, as the motor nerves supplying these extremi-

ties cannot act in obedience to the orders of the brain, until they have regained their tone. On the other hand, the irritation of a motor nerve in its course results in motion of the part to which its filaments are distributed, while a severe injury produces loss of motion.

331. The *production of motion* is a peculiar function of muscular tissue. Motor impulses for the voluntary muscles originate, for the most part, in the gray matter of the cerebro-spinal nervous system.[1] From the cerebral gray matter they are carried by motor nerve filaments to the anterior columns of the cord upon the same side of the body, or to the antero-posterior columns on the opposite side, and to the motor nerves communicating with these columns.[2] From the gray matter of the cord, motor power passes out through the anterior horns, to be distributed by the motor nerves in connection with them. *Only those motions can be considered as voluntary which emanate from the brain.*

332. Of the *cranial nerves* (Fig. 70) there are twelve sets, numbered from one to twelve, in the order in which they arise from the base of the brain, the enumeration beginning at the front of the cerebrum and continuing backwards. These nerves, with the exception of those distributed to the interior of the nose, eye, and ear (termed nerves of special sense), are either motor or sensitive, or are mixed nerves, and convey both sensation and motion. The cranial nerves which concern us at the present time may be briefly described as follows.

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[1] The involuntary muscles are moved through the sympathetic system of nerves.

[2] The nerve filaments passing to and from the *cortex*, or enveloping mass of gray matter of the cerebrum, for the most part pass through ganglia at the base of the cerebrum. Of these, the *optic thalami* (one in each hemisphere) are believed to be sensory centres, and the *corpora striata* (one in each hemisphere), motor centres.

333. The *fifth pair* of nerves are the great sensitive nerves of the face and the side of the head. They possess also motor fibres (derived from distinct roots) which are distributed to the muscles of mastication. Each of the nerves of this pair has three main trunks. The upper one passes from the cranial cavity into the orbital cavity,[1] sending filaments to the eye and adjacent parts, then out through a notched opening in the skull underneath the eyebrow, towards its inner side,[2] and is distributed to the forehead and top of the head. The second branch, after leaving the cranial cavity, runs along the floor of the orbit, giving off branches to the upper teeth, gums, to the mucous membrane of upper jaw, etc., and then out of an opening just below the front lower edge of the orbit, and is distributed to the middle portion of the face, the nose, cheeks, and upper lip. The third branch, with which the motor nerve filaments are associated, supplies mainly sensitive fibres to the mucous membrane of the cheeks, lips, and front part of the tongue, and to the lower teeth, and emerges at an opening in the front part of the lower jaw, to be distributed to the lower lip, chin, and adjacent parts. (Fig. 73.) Irritation of this nerve by disease or other cause produces exquisite pain, as in neuralgia, headache, or toothache.[3]

334. The *facial* or *seventh pair* of nerves are the great motor nerves of the face, the nerves of expression, by which the features are animated by various movements, in response to the emotions. Each nerve of the pair emerges from the skull near the external opening of each ear, and is distributed to the muscles of the face. When these nerves are irritated or diseased, convulsive twitchings of

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[1] The cavity in which the eye rests.

[2] Pressure at this point, or where the other two branches emerge, is attended by sensitiveness.

[3] Neuralgia, *i.e.*, pain in a nerve.

the face and unusual expressions result. If the injury is confined to the nerve of one side of the face, only the facial movements upon that side will be disturbed or made impossible.

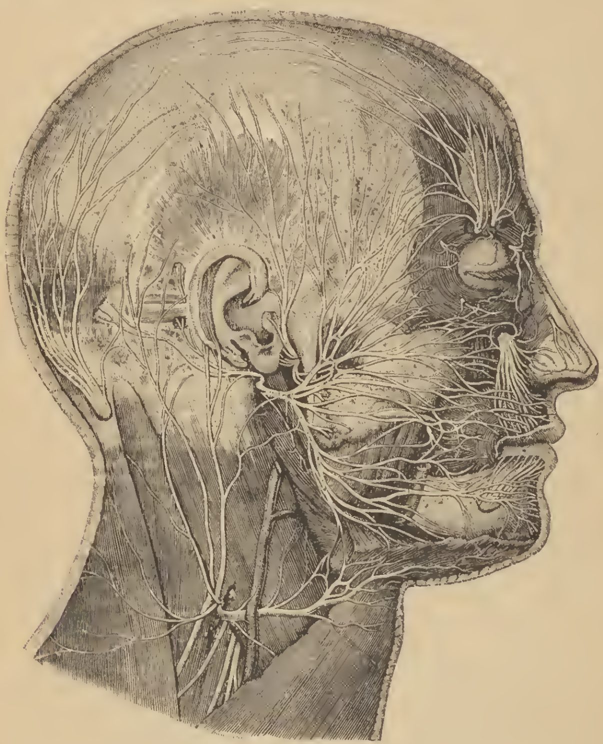

Fig. 73.
Superficial branches of the seventh and the fifth pair of cranial nerves.

335. The *pneumogastric* or *tenth pair* of nerves are mixed nerves. Their distribution is wider than that of any nerves in the body, and their influence greater, for they supply the larynx, pharynx, heart, and lungs, the stomach, intestines, liver, and other abdominal organs with

sensibility and motion, and are connected at various points with the sympathetic system of nerves.

336. The *sympathetic system of nerves*, or the great sympathetic nerve, as it is sometimes called, consists of a double chain of ganglia on the sides of the spinal column; also of scattered ganglia in the head, neck, chest, and abdomen. These ganglia are connected with each other by filaments, and with the cerebro-spinal nervous system, by motor and sensitive fibres. From them numerous and very delicate fibres are distributed chiefly to the alimentary canal and its appendages, the heart, blood-vessels, and certain other organs.[1]

Fig. 74. (DALTON.)
Diagram of pneumogastric nerve, with its principal branches. — 1, pharyngeal branch; 2, superior laryngeal; 3, inferior laryngeal; 4, pulmonary branches; 5, stomach; 6, liver.

At various points the sympathetic nerves, with their ganglia, form about certain large arteries matted nets, or "plexuses." A typical one is the *solar plexus* so called because its radiating nerves branch out like the solar rays. This is situated in the abdomen, some of its filaments accompanying the branches of the aorta distributed to the

[1] These nerves, distributed to the blood-vessels, are known as *vasomotor* nerves, and the continuous muscular action they furnish as the "tone" or the "tonic contraction" of the arteries.

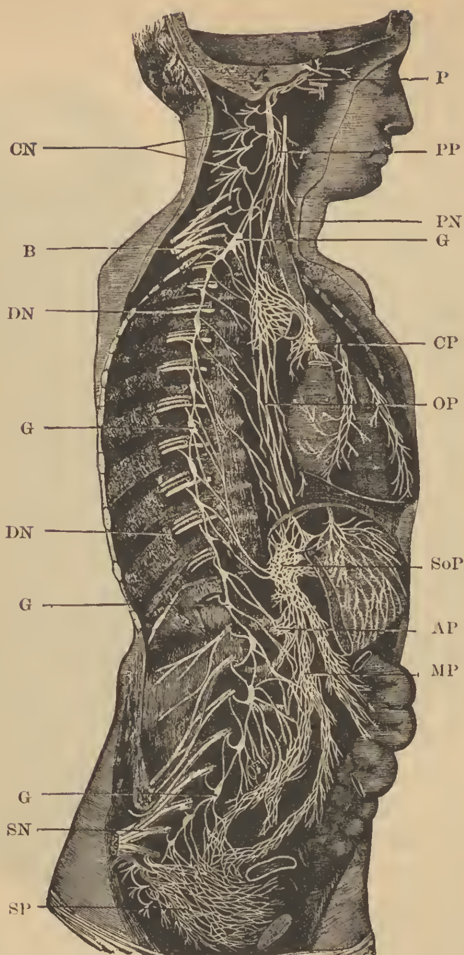

Fig. 75.

Vertical section of body, showing sympathetic nerves and ganglia of right side, and their connection with the cerebro-spinal nerves. — *Cerebro-spinal system:* CN, cervical nerves; B, nerves distributed to the arm; DN, dorsal nerves; SN, saceral nerves, some of which are distributed to the leg; PN, pneumogastric nerve. *Sympathetic system:* P, plexus in the head; PP, pharyngeal plexus; CP, cardiac plexus; OP, oesophegeal plexus; SoP, solar plexus; AP, aortic plexus; MP, mesenteric plexus; SP, saccral plexus; G, some of the ganglia of the sympathetic system.

stomach, intestine, spleen, pancreas, liver, and other organs. An injury to this plexus, as by a severe blow upon the abdomen, is likely to result in sudden death. When persons are said to die of "concussion" or "shock," death results from a severe disturbance of the sympathetic system. Soldiers have been known to die suddenly, without any mark of injury being found upon their bodies, from the passage very near them of cannon balls. Squirrels and other small game are sometimes killed by good huntsmen by bullets fired close to the head. Fish, especially pike, have been stunned or killed when within a few inches of the surface of the water, by a sharp blow struck upon the water just above them, or by the close contact of a pistol ball.

337. The sympathetic system, as has been said, controls, for the most part, the involuntary processes, such as circulation, respiration, and digestion, so that ordinarily in health we do not realize we have a heart, lungs, and stomach, so quietly does the vital machinery work. Yet, owing to the connection of the sympathetic with the cerebro-spinal nerves, the functions of the internal organs may be disarranged by apparently slight causes. For example, emotional disturbances, such as terror and fear, will contract the arterioles, and thus cause paleness, while shame and joy will cause blushing by the dilation of these vessels. Even unpleasant sounds, odors, or events, will sometimes interfere with digestion, the action of the heart, and the secretion of tears.

QUESTIONS.

1. What functions or processes may be considered as peculiar to animals?
2. What is meant by the irritability of organs, and to what is it due?
3. What is the object of the nervous system, and to what may it be compared?

4. What two kinds of nervous tissue are there? Which is the more abundant?
5. Where is each located?
6. What are nerve filaments? nerves? the neurilemma? the function of nerves?
7. Describe the gray matter; the ganglia, and their function.
8. What three divisions has the brain? How are the brain and spinal cord divided longitudinally?
9. Name and describe the three coverings of the brain and spinal cord.
10. On what several things does the working capacity of the brain depend?
11. Describe the cerebrum and its hemispheres. What do the convolutions indicate?
12. What relation have the hemispheres with each other and with the body?
13. What is the office of the cerebrum? of memory?
14. What effect has mental exercise upon the cerebral substance? What follows from this?
15. Describe the cerebellum and its function. The medulla oblongata.
16. Why is the medulla oblongata a very important part of the brain? How is it protected?
17. Describe the spinal cord. Which parts convey sensations? which motor impulses?
18. What are the spinal nerves? Which of their roots convey sensations? which motor impulses?
19. How are sensations conveyed to the brain?
20. How is motion produced? where originated? How is the motor impulse transmitted?
21. What is the effect of irritating nerves midway in their course?
22. What follows the division of nerves or of the spinal cord?
23. What are the cranial nerves? Whence do they issue? How many are there?
24. How many and what branches has the fifth pair? What causes toothache?
25. What pair constitutes the facial nerves? What follows their use? their injury?
26. Describe the tenth or pneumogastric nerve.
27. Describe the sympathetic system, and its ganglia and plexuses.
28. Over what processes does this system preside? What is its normal action? What may ensue from a sudden shock to a plexus?

CHAPTER XV.

NERVOUS SYSTEM, *Continued.* — NERVE FORCE.

338. The peculiar power transmitted by the nerves is known as *nerve force.*[1] In character and rapidity of movement it resembles the electric current.[2] So rapid is the transmission of nerve force that it seems almost instantaneous. Dr. Flint states that "the rate of conduction in the human subject is essentially the same in the motor and sensory nerves, being, according to the most reliable estimates, about *one hundred and eleven feet per second.*"[3]

339. *Nerve force is put in motion by stimuli*, within or without the body, such, for example, as food, waves of light and sound, the emotions, and the applications of electricity and other agents, and, when aroused, manifests itself in voluntary and involuntary functions, and in the various motions and sensations incident to the body.

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[1] The ancients believed that nerve force was a fluid, and hence called it "the nervous fluid."

[2] The electric shocks furnished by the electric eel, when handled, emanate from organs especially adapted to the purpose, which organs are under the control of the nervous system.

[3] Some estimates give the rate in motor nerves at about 250 feet per second. An act of volition is said to require $\frac{1}{28}$th of a second; a simple distinction or recognition of an impression, $\frac{1}{25}$th of a second.

"In the case of the ear, when the sound attended to is that of two electrical sparks quickly succeeding each other, it can be perceived that there are two, and that one is earlier than the other, when it precedes it by no more than 0.002 sec." — *Physiology.* Powers.

Certain parts of the body, by reason of their function, possess extreme excitability, and nerve force is aroused to great intensity by very slight causes. A minute particle of thread lodging in the larynx, by its irritation, induces, in the first place, coughing, then contraction of the laryngeal muscles to effect its expulsion. If the offending object is not readily expelled, other muscles, such as the diaphragm and the chest muscles of respiration, begin to act in concert, and it may be that before the effort at expulsion is effectual, many of the muscles of the entire body have united in the effort to get rid of the insignificant particle. The sufferer meanwhile becomes "black in the face" and exhausted from the venous congestion caused by the powerful contraction of all these muscles.

340. Sometimes nerve force is said to be *transferred; i.e.*, pain or some other kind of sensation is felt in an altogether different part from that where the stimulus really is; as, for example, in disease of the hip joint, pain in the knee is a common sign, while at the hip it is comparatively rare. So, too, when the lungs are irritated, the impression is transferred to the nerves of the larynx, and coughing results. Again, the sun's light falling strongly upon the eye, excites tickling in the nose and sneezing.

341. So called *nervous actions* result, either from the direct transmission of nerve force by motor and sensory nerves to and from nerve centres, or by special nerves through the special organs of sight, hearing, taste, and smell, or from the reflection from one set of nerves to another, through a nerve centre. An impression conveyed to a nerve centre by a sensory nerve, and from thence *reflected* to the motor nerve, results in muscular movement or secretion, which are said to be the effect of *reflex*

action. For the performance of reflex action it is essential that the continuity of the sensory nerve be intact between the terminal point irritated and the nerve centre, that the nerve centre be healthy and uninjured, and that the continuity of the motor nerve be intact from the nerve centre to the glands or muscles acted upon.

342. Reflex action occurs frequently in the body and in both divisions of the nervous system. For the most part it is performed without the knowledge of the individual, but when it occurs through the brain it becomes appreciable, and may even be voluntarily aided. For example, the act of swallowing is mainly the result of an unconscious reflex action by the mere contact of substances with the pharynx. But if an irritant, such as the end of a feather or of a finger be thrust into the throat, involuntary efforts at expulsion are made, and these may be aided by the voluntary efforts of the individual. The reflex action of the medulla, by which ordinary respiration is carried on, is generally automatic, but, when the breathing air becomes vitiated so that we experience discomfort, or when nervous force is irregularly and insufficiently supplied to the lungs, we become conscious of forced and irregular breathing, and may lend voluntary assistance to the automatic efforts. The act of winking is the result of a reflex action, and occurs generally without our knowledge, but may also be performed at will.

343. There are certain reflex actions effected through the cerebro-spinal nerves, in conjunction with those of the sympathetic system, of which we are conscious, but over which we have ordinarily no control. Of the results of these may be mentioned coughing, vomiting, the secretion of tears from irritation of the eyes by dust, etc., blushing or paleness as the result of emotions, the closure of the

eyelids at a sudden flash of light, and a grimace on suddenly inhaling an unpleasant odor.[1]

344. The *reflex actions of the sympathetic system*, *i.e.*, those exerted through the sympathetic nerves and their ganglia, we are not even conscious of, except in some diseased conditions of the body. Such actions result in secretion, excretion, absorption, peristaltic movements, the contraction and dilatation of the pupil of the eye in regulating the admission of light, and the variations from time to time in the volume and rapidity of the blood current in the numberless capillaries of the body.

345. *Reflex actions through the spinal cord* afford good examples of involuntary muscular actions unconsciously performed. Such a reflex action, as Dalton states it, is "merely the transfer of a sensory impression through the gray matter of the cord to a motor nerve." Hence, if the spinal cord be severed at any point, though the power of *voluntary* motion is at once lost in all parts below that point, *i.e.*, paralysis occurs; yet, if the reflex activity of the spinal cord below the severed point remains intact, and the foot be tickled, the foot and leg will be hastily drawn away from the irritation. In the same way a hand or foot, accidentally coming in contact with a hot substance, is instantly snatched away before the brain has had time to take cognizance of the danger. The instinctive efforts made to hold or regain one's footing, when jostled in a crowded vehicle or slipping upon the pavement, are also due to like reflex impulses. If the spinal cord is

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[1] Sometimes pressure upon the upper lip will prevent sneezing, and diversion of the mind by new scenes or objects will stop an irritating cough, or even prevent vomiting. A surgeon, after taking an active emetic, was almost immediately called upon to perform an important surgical operation. Not till after the operation was performed and the anxiety was over did the emetic take effect.

inflamed, or is under the influence of strychnine, or any other stimulating substance, the sensitiveness of the gray matter of the cord to impressions is greatly increased. In such instances, convulsions readily occur by contact of the body with a draught of air, or by the noise caused by the sudden shutting of a door. In cold-blooded animals the reflex activity of the cord remains for a considerable length of time, even after the brain has been removed and the animal is practically dead. A decapitated frog will jump in a natural manner when the feet are pinched or irritated.

346. The voluntary faculties may be educated to act in a sort of reflex manner. Actions, which at first are purely voluntary and consciously performed, may, by frequent repetition, become habitual and be apparently unconsciously performed. They have been called *artificial reflex actions*, and are common. The expert pianist plays the most intricate music, without any apparent thought upon his part as to how his fingers are to move, and it is a common experience for persons to walk, eat, and even read in an automatic manner, while their thoughts are abstracted on other matters.[1] Children, by imitating the odd habits or actions of others, sometimes acquire similar habits which may be very difficult for them to eradicate.[2]

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[1] It is said that a soldier, while carrying a bowl of soup, suddenly dropped it on hearing some one call "attention," so accustomed was he at that word of command to stand erect with his hands by his sides. Convalescing soldiers in military hospitals have been known to jump out of warm beds and stand erect at hearing the word "attention" shouted in through the door by a would-be joker.

A gentleman, accustomed to eat apples while reading, often reached out his hand for an apple, while his thoughts were busy on the book. One evening a friend, unperceived, added a number of apples to those already in the dish; but the reader unconsciously ate apple after apple, until all were gone.

[2] The unconscious performance of ordinarily conscious actions has been termed "unconscious cerebration."

347. Sometimes during sleep, actions such as walking and writing, or even intellectual efforts of a high order, are performed. Sleep-walkers or somnambulists have been found carefully balancing themselves on the ridges of house-tops, or engaged in other perilous feats. To awaken them suddenly, and so disarrange the nervous control of the muscular movements, may prove dangerous.

348. In health, the reflex actions have, for the most part, a distinct purpose, in some way related to the well-being of the body, and it is only in some disordered or diseased condition of the economy that we appreciate any irregularity or want of harmonious nervous action. Hence it is that the healthy, robust man or woman often fails to have any sympathy with the "ailing" persons subject to irregular reflex nervous actions, which cause pain, uneasiness, nausea, and discomfort. A strong will may more or less control many of these actions, and a weak one will be more or less controlled by them. For example, the reflex action of crying out when in pain is sometimes prevented by biting the tongue, clenching the teeth, or by holding some object very tightly. So, too, the yielding to the sensation of tickling, or to the involuntary closing of the eyes when a blow is aimed at the head, may, in a similar way, be prevented. But Mr. Darwin gives a striking example of an instinctive reflex act overriding a very strong effort of the will. "He placed his face against the glass of the cobra's cage in the reptile house of the Zoölogical Gardens, and though, of course, thoroughly convinced of his perfect security, could not, by any effort of the will, prevent himself from starting back when the snake struck with fury at the glass." In young children the nervous system is delicate and very susceptible to impressions. Reflex actions are especially frequent and some-

times attended with danger, especially in children of excitable temperaments, and who have a tendency, by inheritance or otherwise, to nervous disorders. In such children, indigestible food, dentition, fright, etc., may cause convulsions, epilepsy, or even death.

349. The *quantity of nerve force and the amount of nervous energy which each person possesses* cannot be definitely stated. Most individuals have more than is required for the ordinary necessities of life. The surplus constitutes a reserve force which is stored away for emergencies. In times of trial, feeble and apparently inefficient persons sometimes display more "nerve" and have greater nervous energy than persons whose ordinary physical powers are much stronger; while, on the other hand, persons of robust appearance may prove almost valueless on such occasions. Some persons, especially those who are not in robust health, are particularly susceptible to nervous impressions, and in them the reserve nervous force is liable to be recklessly drawn upon. Even persons of strong physical and mental powers, who do not readily succumb to various forms of dissipation, and who freely indulge in excessive pedestrian exercises, over-eating and drinking, late hours, etc., may be unduly taxing their reserve supply of nervous force, while believing that they are too strong and well to be affected by the drain. But the persistent overtaxing of our powers, whether mental or physical, will sooner or later exhaust the nervous system, and reduce us to mental or physical bankruptcy. (*a*.)

350. Disease, the excessive concentration of the thoughts upon one's self by vain and selfish persons, excessive mental or physical work, and, above all, worry, especially if associated with lack of rest, of pure air and suitable food, create a disturbance or *perversion of nerve force*, even in

those who are considered strong, mentally and physically. (*a.*) Such perversion produces a variety of so-called nervous disorders, such as nervous prostration, nervous exhaustion, nerve tire, and hysteria, (*b.*) attended by oversensitiveness of various parts of the body, or a numbness or diminished sensitiveness, increased irritability of the emotions, a tendency to spasms of voluntary and involuntary muscles, and to sudden congestions of blood.

351. Many of the nervous disturbances, to which all are more or less liable, can be warded off by a *proper development of the nervous system*, and the consequent strengthening of nerve force and energy. Such a development is therefore an important factor of health, and may be attained by systematic and proper exercise of the nervous system, just as muscles and other organs are developed by regular and appropriate exercise. Exercise, however, which is improperly adapted to the age, health, and condition of the individual, results in a loss of nerve power. Like other portions of the body, the nervous system needs for its maintenance and health sufficient and wholesome food, adequate exercise and rest, and all other hygienic necessities. Mental labor in excess is, contrary to the belief of some persons, as exhausting as excessive physical labor, and cannot, as a rule, be pursued for so long a time. The amount of nervous energy which each person should expend depends upon the capacity of the individual. No person, however, should work up to the full measure of his ability. Moderate labor, regularly and systematically pursued, will accomplish more than any amount of spasmodic effort, and will not be attended with such danger to the system. As far as possible, therefore, regular mental and nervous work should supersede irregular work, and monotonous labor be replaced by

varied exertion, if we are to gain and maintain a "sound mind in a sound body." Gradually increasing and systematic mental work, proportionate to the health and nervous power, does not pull down the average man. (*a.*) It is the spasmodic overwork in the struggle for wealth or fame, the perplexities which result from suddenly assuming duties one is not capable of performing without a course of preparatory training, that do the mischief. The worry which all such work excites is a bar to sound mental and nervous health, and is oftentimes the factor which turns sanity into insanity.

QUESTIONS.

1. Describe nerve force and its rapidity.
2. How is it aroused?
3. What is meant by the transferrence of nerve force?
4. By what forms of transmission of nerve force are nervous actions rendered possible?
5. What is reflex action, and what is essential for its performance?
6. When are reflex actions recognized by the person in whom they occur?
7. Give some examples of reflex actions of which we are conscious, but over which we have little or no control.
8. Describe the reflex actions of the sympathetic nervous system; of the spinal cord.
9. What is meant by artificial reflex actions?
10. What is the difference between reflex actions in health and disease?
11. What is said as to the quantity of nerve force and nervous energy which each person possesses?
12. How may nerve force be abused?
13. How can mental and nervous health be best produced and maintained?

ANALYSIS OF CHAPTERS FOURTEEN AND FIFTEEN.

THE NERVOUS SYSTEM.

I. Anatomy.

- Divisions . .
  - The cerebro spinal . . . . . .
    - Brain and spinal cord, with their nerves.
  - Sympathetic or ganglionic . .
    - Certain ganglia and nerves.
- Structure . .
  - White nervous matter
    - Nerve filaments or fibres.
    - Nerves.
  - Gray nervous matter, — Cells, etc.
- Arrangement
  - Ganglia (including brain).
  - Nerves, single and combined in columns.
- Protection . .
  - Coverings of Brain.
  - " Spinal cord.
  - " Nerves.
- Nutrition, or blood supply.

II. Physiology.

- Function . .
  - To furnish nervous irritability.
  - To provide sensation, motion, etc.
  - To harmonize all the processes and movements of the body.
- The agent, — Nerve force . . . .
  - How and where aroused.
  - How transmitted.
  - Effects of.

III. Hygiene.

Proper Stimulation.
" Nourishment.
" Rest.

CHAPTER XVI.

SENSATIONS.—THE SENSES: TOUCH, TASTE, AND SMELL.

352. The mind, by means of *sensations*, obtains a knowledge, first, of the condition of the various parts of the body; and second, of external objects and phenomena. The first-named class may be termed *common sensations;* the second, the *special sensations* or the *senses.* Under the first head are those which cannot be distinctly localized, such as fatigue, discomfort, and faintness, and also such sensations as itching, creeping, tickling, aching, and burning. Tactile sensation, or that obtained by "contact," constitutes what is commonly known as the sense of touch. The line of demarcation between many of the common sensations and this sense is not a clear one. In fact, as Kirke [1] says, though "touch is usually classed with the special senses . . . it forms the connecting link between the general and special sensations"; for the sensations produced by stimulation of the nerves of the skin and of certain portions of the mucous membrane are numerous. Of these may be named the sensations of ordinary touch, of weight, heat, cold, and tickling, and, if the stimulation is strong, of pain. Some parts of the skin are more sensitive to certain impressions than to others, and at times one sensation in a part is experienced after others are lost. Pain is probably more easily induced in the face than elsewhere. The cheeks and ears seem to be more sensitive to the changes of atmospheric temperature

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[1] *Handbook of Physiology.*

than other parts of the face. The soles of the feet, the knees, and the armpits are particularly sensitive to tickling. The power of distinguishing heat and cold may be lost in a part, as in paralysis, and yet the sensations of touch and pain remain; or pain may be prevented by anaesthetics before the sensation of touch disappears.

353. The sensation of weight, resistance, etc., is called by some physiologists *the muscular sense*, from the belief that to a great extent it is dependent upon the muscular nerves, and is, therefore, a peculiar property of muscles. It is most developed in those parts of the body where the tactile sensibility is the keenest, and is probably due in part to the relative amount of the pressure of bodies upon those parts, and also to the relative amount of nervous and muscular energy expended in sustaining or resisting bodies. It is an aid in enabling us to appreciate the "resistance, immobility, and elasticity of substances that are grasped, or on which we tread, or which by their weight are opposed to the exertion of muscular power."[1] Habit and education have a great deal to do with this sensation. It is astonishing with what accuracy experts will detect a departure from the standard weight in handling barrels of flour and other packages, including even such light articles as coins.

354. Fortunately, in health, *the application of stimuli, beyond what may be considered in each individual the natural limit of stimulation, is attended by discomfort or pain.* Tickling, for example, at first may not be unpleasant, but if persisted in, is liable to become exceedingly disagreeable and painful, and may be carried to such a point as to become dangerous. "The muscles, though they are not very sensitive organs to ordinary stimuli,

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[1] *Text-book of Physiology.* FLINT.

yet, when contracted spasmodically, occasion severe pain. They ache when fatigued, and pain is felt when they are contused or cut." Sunlight, too, so necessary for health and comfort, if intense and shining into one's eyes, will produce pain and blindness. Long-continued and high-pitched sounds also fail at length to be appreciated as sounds, and produce only painful sensations. This sensibility to pain guards us from many and great dangers. Those parts of the body which are the most subject to injury are supplied with nerves in the largest quantity, and are most sensitive. A cut into the skin, or the application to it of heat, cold, or other irritant, ordinarily causes pain; but the structures beneath the skin are comparatively insensitive.[1] The eye, also, so necessary to a pleasurable existence, is abundantly supplied with nerves of sensation.

355. Were it not for this sensibility to pain, important parts of the body might be irreparably injured without the knowledge of the individual. Thus, the skin might be almost boiled by the hot water of a bath, or roasted by exposure to a hot fire, or the eye might become intensely inflamed by long exposure to bright sunlight, or by the continuance therein of foreign particles which have lodged upon the surface of the ball. This sensibility undoubtedly differs in degree in men and animals.[2] In man it probably bears some relation to the development of the intellect. It is a matter of common observation among physicians and surgeons, that some persons suffer more than others who are afflicted with the same diseases or injuries.

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[1] In a surgical operation, cutting through the skin is the most painful step, but this pain is very frequently diminished or avoided by the application of cold to the part, by means of ether spray or other quickly evaporating material.

[2] "Blooded" horses are much more sensitive and more keenly alive to pain than the average dray or work horse.

356. The *special sensations*, or *the senses*, are generally spoken of as five in number; viz., touch, taste, smell, sight, and hearing.[1] All of the organs of special sense are, however, but the *working tools of the brain.* Hence, to perform their wonderful work aright, not only should they be perfect in structure, but the brain also, and the special nerves which connect these organs with the brain, should be in an alert and healthy condition,[2] otherwise it may be that we shall neither hear with the ears, nor see with the eyes, nor taste with the tongue, nor handle with the hands. During deep sleep, for example, impressions of sound may be presented to the ear, or of chilliness to the skin, and they will not be perceived. During the deep sleep produced by anaesthetics, great surgical operations are performed without the knowledge of the individual operated upon. But when the sleep so produced is not profound, the various steps of an operation may be recognized and afterwards remembered, though the ability to move and the perception of pain may be absent.

357. It is to be especially noted, first, that each nerve of sense is only capable of performing the function designed for it. The nerve of sight does not enable us to hear, and the nerve of smell only enables us to appreciate odors; second, cultivation of the senses, especially if begun in early life, will develop their usefulness, but the training may be carried to the extent of making them

[1] Some physiologists, believing that the several sensations produced by stimulation of the cutaneous nerves, and of those of certain portions of the mucous membrane, are effected through distinct sets of nerve fibres, enumerate as among the senses the sense of pressure, of temperature, of pain, etc. Others claim that all the senses are but modifications of the sense of touch.

[2] As sight, hearing, and touch seem to be most concerned with the wants of the intellect, they are sometimes spoken of as the *intellectual senses;* while taste and smell, being intimately connected with nutrition, are known as the *corporeal senses.*

sources of misery. Certain persons are painfully conscious of the slightest discord; others almost instantaneously detect, with a feeling of disgust, the inharmonious blending of tints which, to the average person, is a harmonious one; others still are made uncomfortable by an odor which is perceptible to no one but themselves. Cultivation furnishes the accurate hearing of the educated musician, the keen eyesight of the reliable pilot, engineer, and expert microscopist, and the accurate touch of the blind.

358. That provision by which we appreciate by actual contact the size, form, and character of the surface of objects, is the *sense of touch*, and is most acute where the tactile corpuscles are most numerous, as in the tip of the tongue, the under surface of the ends of the fingers, and the palms of the hands. It is least acute on the middle of the back.[1]

359. The human hands, with their long flexible fingers and very adjustable thumbs, with their beautiful adaptation to the wants of the whole upper extremity, and with their average of 20,000 papillae to each square inch of surface, are the parts of the body most usually employed in the exercise of the sense of touch.[2] The sensitive tips of the fingers, protected though they be by the epidermis, nails, and cushions of fat, enable us to feel accu-

[1] The delicacy of the tactile sensation may be measured by lightly applying at one time the two points of a pair of compasses to any part of the integument, the eyes being closed. In proportion as the parts tested are sensitive will the two points be perceived as two points when brought very close together. In this way it has been ascertained that the palmar surfaces of fingers and hands are more sensitive than the dorsal surfaces, the front of the body than the rear.

[2] In the cat and seal, for example, feeling is in part effected through the long bristles upon the lips, which are connected at their bases with nerve papillae. In some monkeys the extreme end of the tail, and in the elephant the trunk, are organs of touch.

rately, while we are saved from much of the pain that would otherwise ensue, if the fingers were not so protected. If the cuticle should become removed, and the ends of the sensitive nerves be exposed to the air, pain would result, and the sense of touch be lost.

360. Touch is the simplest of all the senses, and the one which is apparently first developed in the infant, and is common to a greater or less extent in all forms of animal life. Simple as the sense is, it is capable of wonderful development, especially in persons deprived of one or more of the other senses. The blind learn to read by means of slightly raised letters, to recognize persons by feeling their faces, to distinguish by touch the different plants, the minute markings upon precious stones, the delicate tracery upon works of art, and, assisted by the sense of smell, even the color of fabrics.[1] They may become expert musicians and also good sculptors, for it is related of the blind sculptor, Giovanni Gonelli, that he could model the most striking likenesses, entirely by the sense of touch. Physicians, by education, may acquire the *tactus eruditus*, or discriminating touch, which is so valuable in detecting any unusual thickening, swelling, heat, etc., of parts.[2] The expert pianist acquires the ability to handle with precision many keys in a few seconds of time, while the compositor accurately sets type with almost incredible rapidity.

361. *Taste* is the sense by which we discover and recognize the flavors of substances. It is made possible through

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[1] It is said that a blind country merchant was in the habit of selecting shawls and dress goods for various lady customers, whenever he went to the large cities for stock, and that he seldom failed in taste and judgment.

[2] A well-known surgeon, now dead, performed during his lifetime the most delicate operations, which required the keenest sense of touch. He was a large and rather uncouth looking man, and his hands and the instruments used by him were much larger than the average; but the operations he performed were wonderfully delicate.

the mucous membrane of the tongue, of the soft palate, and of the back part of the throat, these being, in fact, the "organs of taste." The mucous membrane of the tongue is especially adapted to this purpose. It is abundantly supplied with both vascular and nervous papillae, similar to those of the skin; and, in addition, there are large compound papillae on the back part of the tongue, arranged in a V shape, and also smaller ones towards the front part. The papillae are covered with a plush-like epithelium, very delicate, permeable by fluids, and some of them contain simple terminal branches or loops of nerves.

Fig. 76.
Papillae of the tongue. — Magnified 20 diameters.

362. The tongue possesses, as we have seen, general sensibility; but the sense of taste has no distinct nerve,

Fig. 77. (DALTON.)
Diagram of tongue, showing the nerves and papillae, and by dotted lines the direction of the muscles.

as in the case of the senses of sight and hearing. The lingual or gustatory branch of the fifth pair of cranial nerves supplies about two-thirds of the tongue, while the

lingual branch of the glosso-pharyngeal is distributed to the posterior third. These nerves convey sensations of taste to the brain. The tip of the tongue seems to possess the greatest sensibility to savors, next the base, and after this the sides.

363. *Only those substances can be tasted which are dissolved.* These, by endosmosis, penetrate the mucous membrane, thus reaching the nerves of taste. Accordingly, dry sugar or salt, placed upon the tongue, is not tasted till it begins to dissolve. The finer the comminution of food, the sooner is it dissolved and tasted. The dissolving process is much facilitated by the varied movements of the tongue.

364. Taste is one of the means by which we distinguish between proper and improper articles of food. But in determining the nature of such articles, it is assisted by the other senses. Undoubtedly much pleasure is lent to the taste of certain substances by their appearance and odor. Hence, a "cold in the head" will interfere with the taste. The practice of swallowing disagreeable medicines with the nostrils closed is quite common. It has even been affirmed that, if the nostrils are closed and the eyes shut, the taste of an onion may be mistaken for that of an apple. The sense of taste, which in man is naturally more acute than that of smell, is more easily perverted; whereas, in some of the lower animals — dogs for example, — the sense of smell is more acute, so that these animals generally smell before they taste.

365. Such qualities as those called "watery," "astringent," "viscid," "oily," "burning," "mild" and "sharp" are appreciated by the ordinary sensory nerves. "Sweet" and "sour" qualities are believed to be appreciated, in the main, by the gustatory nerve at the front of the tongue;

"salt" and "bitter" qualities, by the other nerve of taste towards the back of the tongue.

366. Taste in the human being, and also in some of the lower animals, *is more or less influenced by imitation, habit, surroundings, and training.*[1] The young baby does not readily distinguish between the taste of oil and that of sugar, but learns the difference by degrees. Children fancy certain articles of food and dislike others, because other members of the family or their schoolmates do the same. Persons living in malarious regions have been known to like the bitter taste of quinine. Inhabitants of certain parts of the world enjoy rancid fats. Morbid tastes are sometimes the result of disease, or disorders of the brain or of the blood. Persons so afflicted will eat with avidity slate pencils and plaster, drink vinegar, etc. That taste may be developed, especially when assisted by the sense of smell, is seen in expert tea and wine tasters. The tasting too frequently of strong condiments or spices blunts the sense of taste for more delicate flavors; so also does the frequent tasting of any one article. The nerves of taste fully appreciate but one flavor at any one time, so that if one is presented before another has disappeared, the result is a mixed or confused taste.

367. In man the *sense of smell* is not so acute as the other senses, and its impressions often need to be confirmed by the others. (*a.*) In dogs, on the contrary, it is very acute, enabling them to track their prey and find their masters by scent alone. It is said that the Esquimaux dogs in the Arctic regions are of great value, because they can detect by the sense of smell supplies of

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[1] When tomatoes were first introduced into this country they were generally disliked. Many a man, who will not eat fat salt pork at home, will relish it at sea or in the army.

food which may be stored in the ice long distances away. By this sense animals escape from their pursuers, if they are to the windward of them.

368. The essential organ of smell is the upper half of the mucous membrane of the nasal fossae or nose cavities. These are separated from each other by a vertical wall, called the *septum*, partly cartilaginous and in part of bone. In the mucous membrane which covers part of the septum,

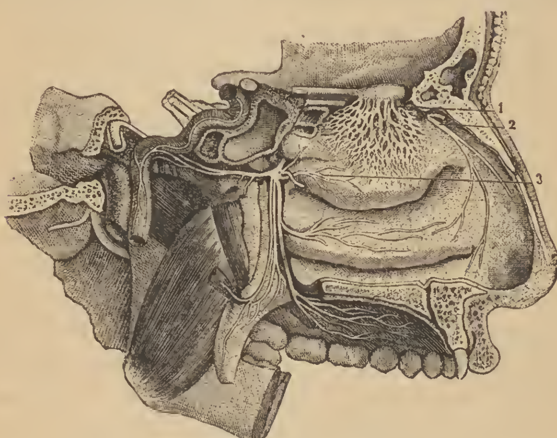

Fig. 78.
Left nasal cavity. —1, left olfactory bulb with its nerve branches; 2, the nasal nerve; 3, a ganglion, and nerves of the sympathetic nervous system.

and on the two upper turbinated bones, are distributed the terminal filaments of the *olfactory nerve*, or nerve of smell. These filaments come through the roof of the fossae, as through a sieve, from the olfactory bulbs which are the terminations of the olfactory nerves. These bulbs lie under the anterior portion of the cerebrum, and upon the bony floor of the cranial cavity. (Fig. 78.) The lower half of the mucous membrane of the nose is supplied with ordinary sensibility by a nasal branch of the fifth pair of cranial nerves. Its irritation causes sneezing.

369. Odors, to be recognized, must be presented in a gaseous or vaporous form to the mucous membrane containing the olfactory nerve filaments. The most minute portion of such a substance as musk will be readily perceived, if it be forcibly drawn up during inspiration into the higher portions of the nasal fossae. Some persons are so susceptible to odors and emanations, that the smell of certain substances, of roses, for example, or of new-mown hay, or of certain drugs in a powdered state, may excite in them an inflammation of the nasal passages.[1] Sharp and pungent vapors, such as that of hartshorn, are perceived by the lower portions of the nasal passages.

370. There is no doubt that the sense of smell may be highly developed, especially in conjunction with that of the other senses, or in case these are deficient. It is related that a certain blind and deaf mute was able to recognize by the sense of smell any person with whom he had previously come in contact. Dryness of the nasal mucous membrane, or its frequent irritation, tend to blunt the sense of smell.

QUESTIONS.

1. How are sensations valuable?
2. How may they be classified?
3. What is the effect of excessive stimulation of nerves?
4. What useful purpose has pain? Give examples.
5. What parts of the body are in general most sensitive? Name some of them.
6. What have you to say of the sensitiveness of different individuals among men and animals?
7. Name some of the sensations experienced through the nerves of the skin.
8. How many special senses are usually reckoned?
9. To what is the sensation of weight probably due?

[1] Hay fever, a form of such inflammation, is believed to be induced by the pollen of the rag-weed, among other things.

10. What is necessary to a healthy exercise of all the senses?
11. Show by examples how the brain is necessary to sensation.
12. Are the functions of the nerves of the special senses distinct from each other?
13. Can these senses be cultivated? How do we know this?
14. What are the objects of the sense of touch?
15. In what part of the body is the sense the most delicate?
16. What service is rendered to the sensation by certain tissues, which are entirely destitute of it, such as the nails, the epidermis, and the fat?
17. How does touch compare with the other senses, as to simplicity and early development?
18. What have you to say as to its capacity for varied application and training? Illustrate.
19. What are the organs of taste?
20. How is the mucous membrane of the tongue adapted to the exercise of this function?
21. Is there a distinct nerve of taste, like the optic nerve for seeing, and the auditory nerve for hearing?
22. What takes the place of such a nerve?
23. Where is there the greatest sensibility to savors?
24. In what form must substances be to be tasted? Why?
25. What relation has this fact to the chewing of food?
26. Of what use is *taste* in addition to its appetizing quality?
27. Do the other senses lend any intensity to the taste? Illustrate.
28. By which of the organs of taste, respectively, are the several qualities of objects supposed to be detected or appreciated?
29. By what is the taste more or less influenced? Illustrate.
30. To what are morbid tastes sometimes due?
31. Give an instance of the capacity of the taste for delicate training.
32. How may the sense be blunted?
33. How does the development of the sense of smell in man compare with that of the other senses?
34. Illustrate the bluntness of the sense by comparison with the lower animals.
35. What is the essential organ of smell? Describe it.
36. How is the lower half of the mucous membrane of the nose supplied with ordinary sensibility?
37. In what form must odors be presented to be appreciated?
38. Illnstrate the extreme sensitiveness of certain persons to odors.
39. Can the sense be trained? Illustrate.

ANALYSIS OF THE SIXTEENTH CHAPTER.

SENSATIONS.

I. OBJECT . . . To gain information, — first, as to the condition of the body; second, as to external objects and phenomena.

II. KINDS . . .
- Common
  - Fatigue, faintness, etc., — Generalized.
  - Tickling, aching, etc., — Localized.
- Special, — *The Senses*: Touch, taste, smell, sight, and hearing.

III. ORGANS . . .
- Skin
- Muscles
- Portions of mucous membrane
- The eye
- The ear
- Internal organs (occasionally)

With sensitive nerves and their connecting nerve centres.

IV. REQUIREMENTS
- Proper stimulation.
- Rest.

CHAPTER XVII.

SIGHT.

371. By means of *sight* we receive impressions of light, movement, and distance, the form, size, shades of color, and other general properties of objects, and, in general, the manifold beauties of nature and art. *The organ of sight is the eye*, and the parts belonging to the eye, or auxiliary to its use, are the eyeball, eyebrow, eyelids, ciliae or eyelashes, lachrymal and Meibomian glands, tear passages, muscles, and optic nerve.

372. Each eyeball rests in an orbital cavity partially surrounded by cushions of fat. The orbits are deep and conical, and are formed by the junction of various bones. Their upper and front edges project and overhang their openings, thus forming the *brows*, which are covered with thick skin, and short, strong hairs. The eyebrows, with the other projecting walls of the orbits, and the nose, serve to protect the eyes from injury. The hairs of the eyebrows prevent the perspiration from flowing into the eyes, by directing it towards the cheeks.

373. In front of each orbit are two movable curtains, known as the upper and lower *eyelids*, the upper being more movable than the lower. When closed, they cover the orbital openings. Both have upon their edges hairs (*eyelashes*) which project outwardly, and when the lids are closed, or even partially closed, interlace with each other, forming an admirable screen. Their bulbs are supplied

with nerves. They are sensitive, and give warning of the approach of insects, dust, etc., even in the dark.

In some persons the eyelashes are long and silky, while in others they are short and stiff.[1] A thin, loose skin covers the lids upon the outside. Their inner lining is a thin mucous membrane, the *conjunctiva*, which also covers the front of the eyeballs. This membrane is extremely sensitive, and aids the eyelashes in protecting the eye from dust and other foreign particles.[2] Between the skin and conjunctiva of the lids are *cartilages*,[3] which serve to preserve the convexity and firmness of the walls of the lids. Between the cartilages and conjunctiva are the *Meibomian glands*, with their tubes lying in grooves in the cartilages. These glands secrete an oily material which lubricates the edges of the lids, thereby preventing them from adhering, and the tears from overflowing upon the cheeks.[4] The lids

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[1] Sometimes when the lids are diseased the lashes turn inward and irritate the eye.

[2] *Conjunctivitis*, or inflammation of this membrane, is one of the commonest affections of the eyes, especially among those whose general health is deteriorated, and who are exposed to dusty or other irritating air, as in factories and some tenements.

"I have no doubt in my own mind," says Dr. Loring, the well-known oculist, "and I believe it is universally admitted, that vitiated air has a direct irritating effect on all mucous membranes, and I feel convinced from my own observation that the mucous membrane of the eye is peculiarly susceptible to its influence. This is shown by the fact that repeated attacks of inflammation of the mucous membrane of the eye, which have occurred in a vitiated atmosphere, and which have resisted all curative means, are often cured at once, and prevented from recurring, when a wholesome supply of air is obtained, all other conditions remaining the same."

In Egypt, owing to the intense heat, to the high winds, and clouds of sand, this and other inflammations of the eye become very severe, even destroying the organ. It is said that many of the Crusaders in the Holy Land were made blind from these causes.

[3] Tarsal cartilages.

[4] The last effect will be better understood if the edges of a cup are greased and the cup is filled with water. The surface of the water may then be made higher than the edge of the cup, without the water overflowing

distribute moisture, or the tear secretion, over the surfaces of the eyes, and assist in regulating the admission of light thereto, and they protect them from heat and cold, and the contact of foreign particles, dust, insects, etc. The eye is closed by the action of a broad, thin, elliptical muscle which surrounds the orbit and spreads out upon the lids. By it the skin and soft parts about the eye are wrinkled and drawn together inward, and the lids firmly held together.

374. At the external and upper portion of the orbits are located the *lachrymal glands*, which secrete the *tears*. This watery secretion, like the insensible perspiration, is constant, and is spread by the lids over the front surface of the ball. A portion is carried into the nose through four openings, one on the edge of each lid, near its inner extremity. These openings may be readily seen by everting the lids while looking into a mirror. They connect with little canals (lachrymal canals), which communicate also with two enlargements, called the *lachrymal* or *tear sacs*, and these latter with the *nasal ducts*, which discharge into the nose. (Fig. 79.) The tear sacs, together with the nasal ducts, constitute the lachrymal canals. The lachrymal secretion keeps the front of the eyeballs in that moist and transparent condition which is necessary for clear vision and comfort. If the eye should become dry, as it does sometimes, from disease, or long exposure to dry, hot winds, it becomes clouded, light being but poorly admitted through

Fig. 79.

LG, lachrymal gland; TD, openings of tear ducts; LS, lachrymal sac; ND, nasal duct. Skin and parts external to these organs removed.

it.[1] Usually this secretion passes into the nasal ducts after performing its functions; but, if largely increased in quantity by emotion or irritation, it overflows in tears upon the cheeks; hence, emotional persons readily weep.[2]

375. Each eyeball is spherical in *form*, and has the segment of a smaller and more prominent sphere fitted upon its anterior portion, somewhat as a watch glass is set into its case. (Fig. 81.) The diameter of the eye from the front backwards is about an inch; the transverse diameter a little less. The segment of the larger sphere, forming about five-sixths of the globe, is opaque, while that of the smaller and anterior sphere, the cornea, which is without blood-vessels, is transparent, light passing through it as through a clear window-glass.[3]

376. The posterior five-sixths of each eyeball is composed of three coats or tunics: the sclerotic, choroid, and retina. The *sclerotic coat* is a white, firm, fibrous envelope of the posterior five-sixths of each eyeball. It has but few blood-vessels, is not very sensitive, assists in maintaining the globular form of the eyeball, and protects the delicate structures within it. To its outer surface are attached the six muscles, four straight and two oblique, which are capable of moving the eyeball in nearly all directions. Upon the front of the eye the sclerotic coat forms what is

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[1] Lustreless eyes are seen in fish which have been removed for a time from the water. In some forms of scrofulous or blood disease in the human being, the Meibomian and lachrymal secretions are decreased in amount, and the eyes become bloodshot and cloudy, giving rise to the peculiar appearance known as "blear-eyed," the defect being enhanced by the roughening and falling out of the eyelashes.

[2] Sometimes, also, where the tissues of the lower lids are relaxed, as in old persons, and the lids are everted, the tears overflow.

[3] The cornea can be best seen by looking at it in the human being from the side, or by observing the reflection of objects upon it. In looking at an eye in front, we look through the cornea and aqueous humor.

called the "white of the eye," and is covered by the conjunctiva. In its inner surface are lodged the *ciliary nerves.* Behind, and a little to the inner side, it is pierced by the filaments of the *optic nerve*, or *nerve of sight*, whose fibrous sheath is continuous with the dura mater of the brain. Along with, and in the centre of, the filaments, there passes into the eye a large central artery, which is distributed to the lining coat. Other blood-vessels, and

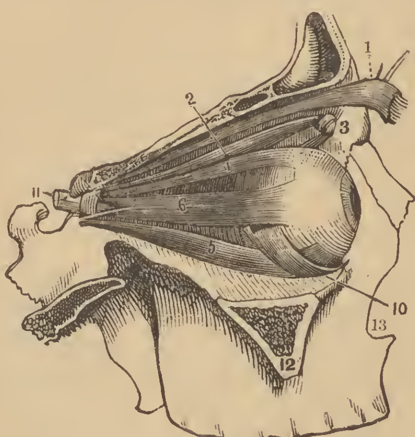

Fig. 80.

Muscles of the eye.—1, the muscle which lifts the upper lid; 2, the superior oblique muscle; 3, the pulley through which its tendon plays; 4, 5, 6, superior, inferior, and external straight muscles; 10, inferior oblique muscle; 11, optic nerve; 12, cut surface of cheek bone; 13, nasal orifice.

also some of the ciliary nerves, pass into the eye, along with the optic nerve, through an opening in the bottom of the orbit.

377. The *choroid*, sometimes called the *vascular coat*, is the middle coat of the eye, and is closely adherent to the inner surface of the sclerotic. It is soft, containing a network of blood-vessels, and is of a dark color, like the inside of the skin of a dark grape, being lined with a

layer of flat, dark-brown, or nearly black, pigment cells. This dark surface absorbs such of the rays of light which enter the eye as would otherwise be reflected and diffused, and prevent accurate vision. In Albinos, also in white rabbits, and other animals having red or pink eyes, the pigment cells are deficient, and accordingly vision is imperfect, especially in the day-time, or when the eyes are exposed to strong light.

378. A prolongation of the choroid, in the front of the eye, forms the *iris*, which is a curtain across the interior of the eye, behind the cornea, at the margin of which it is attached. In its centre is the *pupil*, a round opening, through which all light that enters the back part of the eye must pass.[1] The iris is a muscular organ having two sets of fibres, circular and radiating. Through the involuntary action of these fibres the pupil contracts and dilates, when exposed to greater or less light, thus performing its function of regulating the amount of light admitted to the retina. But the pupil does not act instantaneously; hence, on coming into a bright light from a dark room, or going into a dark room from the bright sunlight, vision is confused until the proper amount of light has been excluded or admitted, as the case may be, by the contraction, or expansion of the pupil, and until the retina also has accommodated itself to the change. Certain medicinal substances

[1] The shape of the pupil differs in different animals. In the cat it is a narrow, horizontal slit when contracted, and is round when dilated. Capable of great dilatation, it enables the cat to see even in the dark. In the human eye the pupil seems black, except in the case of the Albino. The black appearance is due to the fact that, in looking at the pupil, we look into a dark chamber at the back. In the Albino, the pigment cells being deficient, we see the pinkish color afforded by the blood-vessels. In certain nocturnal animals, such as wolves and cats, in obscure light the pupil presents a sparkling or glaring appearance, which at one time was supposed to be due to a kind of phosphorescence, but is now recognized as a reflection from a patch of metallic lustre found upon the choroid of these animals.

have the property of dilating, and others of contracting, the pupil. For example, belladonna, or atropine, which is its active principle, taken internally, or applied to or about the eye, dilates the pupil, while opium and the Calabar bean contract it.[1] The color of the iris varies,

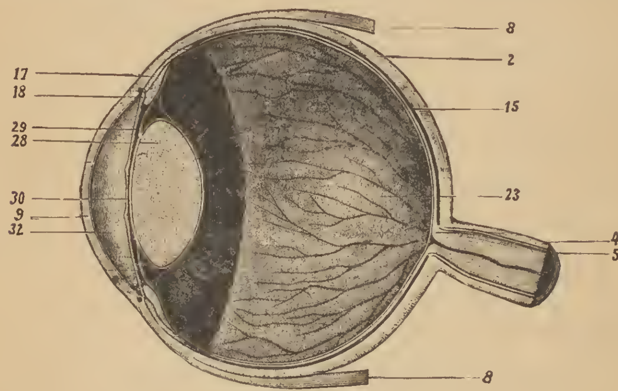

Fig. 81.

Vertical section of the eyeball, and part of the optic nerve.—2, sclerotic coat; 4 and 5, external and internal coverings of the optic nerve, continuous with those of the sclerotic coat; 8, superior and inferior straight muscles; 9, the cornea; 15, the choroid coat; 17, ciliary muscle; 18, ciliary body; 23, branches of central artery of the retina; 28, the crystalline lens; 29, the iris; 30, the pupil; 32, anterior chamber.

and is apt to be in accord with the general coloring of the individual.[2] By the terms, blue, brown, hazel, gray, or black eyes, the color of the iris is indicated.[3] Just behind the iris, towards its circumference, lie the ciliary muscle

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[1] The acts of dilatation and contraction of the pupil may be seen by alternately covering the eye of another with the hand for a moment, and then removing it. In many young persons considerable dilatation is normal, while the same is true of contraction in some old persons. *Extreme contraction or dilatation of the pupil is the result of poisoning or of disease.*

[2] Sometimes brunettes are seen with light eyes, and blondes with dark ones, and occasionally a person is found with one eye light and the other dark.

[3] The eyes of young infants are almost always blue, the color not beginning to change until the sixth or eighth week of life.

and also the ciliary body, a dark pigmented mass, arranged in fluted folds known as the "ciliary processes" (Fig. 81), which, with the iris, control the function of accommodation, to be hereafter described.[1]

379. The *retina* is the third coat, and lines nearly the whole of the posterior five-sixths of the eyeball.[2] It is a delicate, transparent membrane, containing an expansion of the filaments of the optic nerve. It is sensitive only to light. A jar of the retina or optic nerve by a blow upon the head, or an electric shock communicated to the eyeball, or any irritation applied to the retina, produces flashes of light, — an effect which is familiarly termed "seeing stars." The function of the retina is to receive the rays of light which, emanating from objects, enter the pupil of the eye, and communicate the impressions thus produced through the optic nerve to the cerebrum. The retina is not, however, equally sensitive to light throughout its whole extent. The point of entrance of the optic nerve is insensible to light, and is therefore called the "blind spot,"[3] while from one-twelfth to one-eighth of an inch outwardly from this point in each eye is an oval spot called the "yellow spot," which is the most sensitive part of the retina. This spot is directly in the line of distinct

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[1] The iris, ciliary body, and choroid, together are called the *uveal tract*.

[2] Its greatest thickness is said to be not more than $\frac{1}{120}$ of an inch, and microscopists describe eight or ten different layers in it. An outer one contains the "rods" and "cones," which are most intimately concerned in the perception of light, while next to the inner coat is the expansion of the optic nerve.

[3] The blind spot may be proved by a simple experiment. Place the two thumbs side by side about twelve inches from the face. Shut the left eye, and look at the left thumb *intently* with the right eye, while you gradually move the right thumb away from it toward the right. At a certain point, generally about six or seven inches, the right thumb will seem to disappear. If carried still farther away, it will be again seen. The explanation of this phenomenon is that, at the point of disappearance, the picture of the thumb falls upon the blind spot.

vision.[1] Each impression received by the retina lasts for a time before fading away. If impressions are received too rapidly, one after another, vision is confused or dazzled, as the case may be, or the objects seem to be one. The old impressions are retained while the new ones are being received. Thus, the spokes of a rapidly-revolving wheel seem to form a continuous disk. A lighted torch rapidly revolved shows a circle of light. Two colors upon a card, if rotated rapidly, are confused by the eye into a blurred image, or, if the colors be primary, the complementary secondary color is perceived.[2] The retina becomes tired and loses its sensibility by looking for a long time steadily at one object, and the sight is relieved by closing the eyes for a moment, or by an occasional glance at other objects.[3]

380. Within each eyeball are three transparent media or humors: the aqueous humor, the vitreous (glass-like) humor, and the crystalline lens. Enclosed within the retina is the *vitreous humor*. It is a colorless, transparent, and jelly-like substance, which assists in preserving the form of the eyeball, and affords support to the delicate retina. On its front, in a cup-like hollow, rests the crystalline lens. Between the lens and the cornea is the aqueous humor, consisting of a few drops of a watery fluid in which the iris can freely move.

381. The *crystalline lens* is located just behind the iris and in front of the vitreous humor, and is about one-quarter of an inch in thickness, is shaped like a double convex

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[1] The yellow spot, upon which the rays of light converge, *i.e.*, are focussed, receives impressions through the motions of the eyeball from side to side as in reading, or in various directions, as we catch at a glance the beauties of a landscape.

[2] Toys for children, in which figures seem actually to be in motion, are constructed on the principle stated above.

[3] Looking steadily for a time at a bright light or spot will cause it to appear dark. After rest this dark color disappears.

lens or magnifying glass, and is contained in a capsule, which is kept in place by a so-called suspensory ligament, which is a continuation of the enclosing membrane of the vitreous humor.[1] The lens is of the consistency of jelly, but very elastic, especially in children; consequently, in them the shape is very readily changed, while in old persons the lens is quite dense, and is not easily changed.

The function of the crystalline lens is to assist the cornea in bringing rays of light to a point or "focus" upon the retina. This is necessary to distinct vision, for, without the lens, the rays would not be thus focussed, and sight would be blurred. The crystalline lens, being convex, converges the rays of light which pass through it to a focal point, giving at that point an inverted image of the objects from which the rays proceed. So, in a bright, direct light, by means of a convex lens, objects, such as trees, drawings, etc., may be pictured upon a white or light-colored surface, but always inverted, or upside down. In the same way, through the crystalline lens, inverted images are formed upon the retina.[2] Notwithstanding this inversion, however, in normal vision, these images are seen in their proper positions and relations. We learn to appreciate the size and form of objects reflected upon the retina by comparison and experience. As it is the brain

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[1] Cataract is an opacity of the crystalline lens, and not a "white spot on the front of the eye," as some believe. It may affect the whole or part of the lens. Usually light is transmitted through the lens when so affected, as through a ground glass window. To restore transparent media, or to remove the irritation which such opacity may set up, the lens may be removed by operation. When removed, vision can be in part restored by the use of spectacles or eye-glasses, *i.e.*, artificial lenses.

[2] A candle flame held before the cornea of an eyeball removed from a bullock (the sclerotic and choroid on the posterior of the eyeball being detached) will be seen reflected inverted upon the retina. When the lens has been removed from the eye by operation, the focus of the rays of light falls about three-eights of an inch behind the retina, and the object seems much larger than it really is, and much less distinct.

which is the ultimate organ of perception, a disordered brain will sometimes perceive distorted images in objects of which the retina receives correct impressions; hence, also, apparent vision is possible without any retinal impression at all, the disordered brain seeing some phantom image of its own creation. It is in this way that in dreams objects appear to be so vividly seen that they may be readily described when the sleeper awakes.

382. All the various directions from which rays of light come into the pupil, taken together, form what is known as the "circle" or "field of vision." Immediately in the centre of this field objects can be most distinctly seen. To enable one to have a long or short range of vision at will, to see remote objects, and then, within an incredibly short time, those close at hand, the crystalline lens has a *power of accommodation.* But objects at different distances cannot be plainly perceived at the same time. The lens in each case must be accommodated to the distance. Thus, while we gaze at a fly upon a window pane, or the threads of a veil, we do not see plainly the landscape beyond. If we see the landscape plainly, the fly and the threads of the veil become indistinct. This accommodation is the result of changes in the shape of the lens produced by the ciliary muscle, the small muscle before mentioned, which encircles the lens and is connected with the delicate ligament that holds the lens in position. As the objects looked at are brought near the eye, the lens becomes more and more convex. When the eye is at rest, or when objects are distant, the lens is more flattened. The ciliary muscle bears the same relation to the eye as the adjusting screw does to the opera-glass, photographer's camera, or to the microscope. The range of accommodation is limited, and differs in different

individuals. Ordinarily accommodation fails and vision is imperfect when the object is less than six inches from the eye. Outside or inside of each one's normal limit of vision, or where the lines of sight no longer focus or meet, vision becomes imperfect and blurred. The average eye is able to recognize type one-thirty-second of an inch in

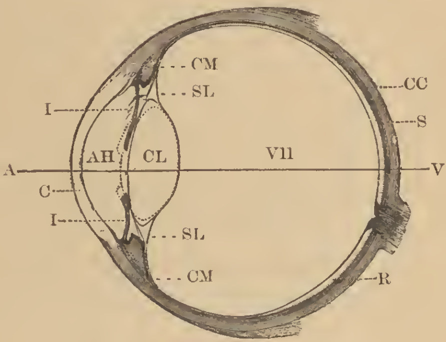

Fig. 82.

Section of eye. — The line A–V is the axis of vision; S, sclerotic coat; C, the cornea; CC, choroid coat; R, retina; VH, vitreous humor; AH, aqueous humor; CL, crystalline lens; I, the iris. The dotted lines show the position of the iris and the shape of the lens in accommodation for a certain distance; CM, ciliary muscle; SL, suspensory ligament of lens.

height, held at least eighteen inches off,[1] and type three-eighths of an inch in height twenty feet away. But the ability to see plainly objects at a distance, or near the eyes, can be developed by training. The pilot clearly defines objects at a long distance, even in an obscure light, which the average eye could not even distinguish. On the other

[1] "The following paragraph from Dr. Snellen of Utrecht, the author of the test-types in general use, gives a specimen of letters one-thirty-second of an inch in height:

"We have adopted as proper objects square letters, the limbs of which have a diameter equal to one-fifth of the letters' height. Such letters are clearly distinguished by a normal eye at an angle of five minutes. As the limbs and subdivisions of the letter just measure one-fifth of their height, they present themselves at an angle of one minute; for instance, our letter C shows an opening, as compared with the O, of one minute visual angle. In testing accuracy of vision, we accept perfect recognition, and not uncertain perception, of the letters."

hand, the watch-maker's eyesight is very acute for objects near at hand.[1]

383. *The optic nerves*, which carry impressions from the retinas to the cerebrum, are inserted into the posterior segment of the eyeballs, a little to the inner side of their centres. Passing into the cavity of the skull, they approach each other and consolidate, forming what is known as the "optic chiasm." At this point there occurs a *decussation of a portion of the optic nerve fibres*, so that some of the filaments pass from the left optic nerve to the right, and from the left eyeball to the right one, and vice versa. Filaments also pass from one optic tubercle, that is, from the origin of one optic nerve to the other.[2] The eyes, as Dalton remarks, "are not so much two distinct organs, as one double one." Besides the direct impressions (color, size, etc.) carried to the brain by the optic nerves, impressions which result in reflex action are brought back to the eye from the optic tubercles. A stimulus of light, for example, is conveyed to the optic tubercles, and is reflected outward to the muscular fibres of the iris, causing contraction or dilatation, as the case may be.

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[1] The eyesight may be brought to a high state of perfection by proper cultivation. It is related of Professor Agassiz that he once selected as an assistant the candidate who could best see and *describe* what was to be seen from an open window. One person saw merely a board fence and a brick pavement, another added a stream of soapy water, while a third detected the color of the paint on the fence, noted a green mold or fungus on the bricks, and evidence of bluing in the water, and other details. Houdin, the celebrated prestidigitateur, in his autobiography, attributes his succees mainly to the quickness of his perception, which he acquired by walking repeatedly and rapidly by a shop window full of miscellaneous articles, endeavoring thus to recognize as many objects as he could at a glance.

In many respects the human eye resembles the photographic camera, with its darkened chamber, reflecting surfaces, adjusting screws, sensitive plates, etc., and like it, in use by an experienced and pains-taking owner, much more accurate pictures will be reproduced than if the owners are reckless or uneducated.

[2] The optic tubercles are cerebral ganglia on the under surface of the brain, near its front portion, in which the optic nerves originate.

384. Objects are ordinarily perceived by the simultaneous use of both eyes, *i.e.*, by *binocular vision*. Two images of each object are formed at the same time, one upon each retina, though so combined as to produce the impression of but one object upon the brain.[1] With binocular vision we appreciate, with greater accuracy, the solidity and distance of objects;[2] hence, with one eye closed, the difficulty of threading a needle, or touching any object quickly, will be much increased. (*a.*)

385. Owing to the extreme sensitiveness of the eyes, *defects in vision* are quite common. In cases of injury to, or disease of one eye, the peculiar decussation of the fibres of the optic nerves may give rise to "sympathetic" inflammation, or disease of the other eye.[3]

The ophthalmoscope, an optical instrument which, used in a dark room, reflects by means of a bright light the inner coats and contents of the eye, was invented by Helmholtz in 1851. It enables the physician to detect optical defects which the patient may not have been aware of. Before the use of the ophthalmoscope many diseased or disordered conditions of the eye were not accurately recognized. It is now known, for example, that defective circulation in the retinal blood-vessels may disturb the vision; and that changes in the form, consistency, or relation of the various parts of the eye may induce grave optical defects.

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[1] The best binocular vision results when the images are both upon the yellow spots. But if this be not the case, if, for example, one eye be pressed a little to one side by the finger, and an object is then looked at with both eyes, the object will seem double, the images falling upon different points in the two eyes.

[2] Looking at a solid object with both eyes, the two images formed upon the retina are not exactly alike, for one eye sees it from one side, the other from another side. The result is a "stereoscopic effect." Double pictures, so drawn that they represent the objects as seen by the two eyes, will, when shown by the stereoscope, appear solid.

[3] As to the removal of foreign bodies, and the treatment of injuries of the eye, see chapter on emergencies.

386. *Color-blindness* is the inability to distinguish certain colors. Helmholtz and others have considered red, green, and violet as base colors, *i.e.*, colors, by the mingling of which in proper proportions, white (a combination of all colors) and the various colors of the solar spectrum may be produced. It is believed that there are special retinal elements for the perception of each of these base colors, and that the color-blind are deficient in one set of these elements, most commonly the red.[1] It is especially important that railroad engineers and seamen should not be color-blind. Vessels carry at night upon their right hand or "starboard" side a green light, and upon the left hand or "port" side a red light. A red light also is the danger signal upon railroads. Color-blind engineers may therefore not distinguish danger signals, or pilots know how to pass an approaching vessel, thereby causing collision and loss of life. Especially are such accidents to be expected if the atmosphere is so humid that these men cannot distinguish the difference in the luminosity as well as in the color of signals. (*a.*)

387. An eye perfectly formed, *i.e.*, one in which the rays of light are made to converge to a focus directly upon the retina, is called an *emmetropic*[2] eye. If the axis of

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[1] Sometimes color-blindness is called Daltonism, from Dalton, the English chemist, who first carefully described it, and was himself subject to it. It is related that his friends were much concerned when he was to be presented at court, for fear that, being a Quaker, he would not wear the scarlet robe which his position required him to wear; but to him it seemed of a gray color.

[2] From the Greek word *emmetros*, *i.e.* regular. Accuracy of vision may "be ascertained by employing the ordinary cards used by opthalmic surgeons, upon which are printed letters (in Roman) of differing sizes. Each line of letters has at the end a number, which denotes the distance in feet at which a person should stand and see the letters clearly. If he can do this, he possesses normal acuteness of vision. According to the usual system employed in eye infirmaries, if a certain line is to be read at a distance of fifteen feet, and the pupil can do so, he is marked $\frac{15}{15}$; if he must go closer, and can only distinguish at eleven feet, he is marked $\frac{11}{15}$, the denominator of the fraction representing the normal distance, and the numerator the actual distance. (*a.*)

the eyeball is too long or too short, the focus will not fall upon the retina, but in front of or behind it. There is then said to be an "error in refraction." In *myopia*,[1] or short-sight, parallel rays of light entering the eye are focussed in front of the retina, the axis of the eye being too long. Objects are not plainly seen until they are brought near enough for their images to be focussed upon the retina. This condition is often hereditary, but is also induced by strain, for example, by reading very small print in a poor light, and by long, uninterrupted use of the eyes in close work. For its relief, properly fitted concave glasses are needed. (*a*.)

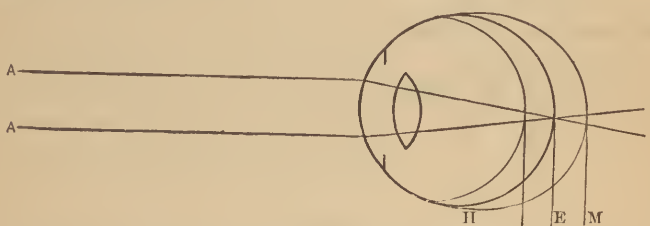

Fig. 83.

A, parallel rays of light; E, emmetropic or normal eye, rays focussing at proper point; H, long-sighted eye; M, short-sighted eye.

388. In *hypermetropia*, or long sight, the axis of the eyeball is too short, and the focus falls *beyond* the retina. This condition is to be remedied by convex glasses, which will converge the rays of light upon the retina. Print, after too long reading, becomes blurred and misty. The performance of accommodation is painful, so sensitive have the parts become, even when there is no attempt to use the eyes, and in children there is always more or less danger of squint resulting from the effort to see things near by.

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[1] So called from Greek words which mean *to close the eyes*, since short-sighted persons often partially close the lids in order to see distinctly.

389. *Presbyopia*, or old sight, is a failure of accommodation, or a loss of power for adjusting the focus of the eye for near objects, and is especially due to the fact that with increasing age the lens becomes stiffer, and incapable of being bent into the convexity necessary for the adjustment of the focus for near objects.[1] To remedy this defect convex lenses are required.

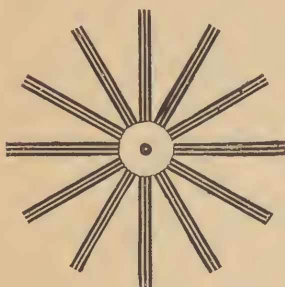

Fig. 84.

390. Another optical defect is *astigmatism*, or the inability of the eye to focus lines perpendicular to each other at the same time. (Fig. 84.) This condition depends upon a difference in the curvature of the different meridians of the cornea or lens. Persons so affected may readily distinguish horizontal or perpendicular lines of type, but not both sets equally well at the same time.

391. *Proper care of the eyes* is of the greatest importance. Healthy and well-formed eyes, if properly used, do their work without the consciousness of their owners, so that pain, or discomfort in them, or even slight defects in vision, are warnings of disorder if not of disease. But persons whose general health is unusually good are liable to be over confident, and so fail to take notice of these warnings in time. Young children are too frequently encouraged in persistent "near work," such as prolonged drawing, studying, reading, and sewing. Such children

[1] Sometimes old people are delighted at the return of what is called "second sight," by which they may be enabled to read without the aid of their accustomed glasses. In fact, they have become short-sighted owing to a change in the shape of the lens, and can see clearly objects near at hand, while objects far off are more indistinct than before.

may become prodigies, but the soundness of their eyes is frequently sacrificed. (*a.*) Most of the eye troubles of infants are the result of the careless exposure of their sensitive eyes to glaring light, or to impure air, in the "living" rooms where the washing of soiled clothing is carried on, or of the application of poultices and other materials to the eye, etc. In adult life certain occupations tend to weaken the eyes, but even in such instances much can be done to save them. The following directions for this purpose are those deemed most important: —

1. For all kinds of work have an abundance of *clear and steady light*, especially when engaged in writing, reading, embroidering, painting, or other work which "tries the eyes." Fine work, and that upon dark surfaces, should be performed by daylight. Using the eyes closely during twilight is injurious.

2. Avoid a glaring light, and see to it that the sun does not shine directly upon your work. Interpose ground glass, or light blue, or gray tinted glass, or paper. The reflection into the eyes of sunlight from the surface of mirrors is not to be tolerated.

3. Let the light reach your work preferably from the *left side* and from *above*, not from in front.[1]

4. When using artificial light (*i.e.*, that from a lamp, gas, etc.), it is beneficial to shade the eyes from any heat and glare. If gas is used, the Argand burner, with its shade and chimney, is advisable. If a lamp, use only the *best oil* and a good lamp, particularly the "German students' lamp." "A slight tinge of blue or gray, in the shade or chimney, modifies the light pleasantly by absorbing the excess of yellow rays."[2] The heat and glare of

[1] If from the right or behind, shadows are cast upon the work.

[2] Coal oil is so cheap now-a-days that there is no need for "tallow dips," or the "slush lights" of the miners, and light from it is much better for the eyes. The electric light (adapted to use in the house) will, it is believed, prove useful for near work.

necessarily bright illuminating rays are sometimes lessened by the interposition of globes filled with water.

5. When reading, it is important that the *type* should be clear,[1] of good size, and printed in dark, not pale, ink; that the *paper* printed upon should have a yellowish tinge, or not be absolutely white.[2] For sensitive eyes faint blue ink may be preferable.

6. Do not read or write when *lying down*, *riding in the cars* or a *carriage*, or when *walking*, or when *overcome with sleep*, for under all these conditions the accommodative apparatus of the eyes is strained. Especially is this true if we read in moving vehicles, for the irregular muscular strain resulting is exhausting to most eyes. Reading during convalescence from any debilitating sickness is attended by an improper strain of the weakened eye muscles.

7. Do not bend over your work for any length of time; such a constrained position tires the muscles of the eye as well as those of the neck and trunk.

8. Prolonged and uninterrupted *tension* of the eyes over any kind of work is injurious, but especially is this true of fine work. Look up and away from the work frequently, directing the sight towards varied and distant objects.[3]

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[1] What is known as "heavy-faced" type should be used, not the "light-faced."

[2] Most oculists believe that the best paper is that which is known to the trade as "natural," *i.e.*, which has no dye in it, and which has been bleached but little, and is not glazed.

[3] Writing tables and desks covered with blue or green cloth, paper, or leather, serve to rest the eyes. Rooms papered and painted in the same colors have the same effect. Smoked or light blue eye-glasses may be worn if the eyes are exposed to glaring light, such as the reflection from snow or sand. It is a disadvantage of city life that the eyes are occupied for the most part with close objects. Excursions into the country are valuable partly for the rest afforded the eyes. It is related of a city boy, that, when taken from the tenement in which he lived to the country, he went into raptures, exclaiming, "that he never knew there was so much sky."

If the eyes pain, or are fatigued, or the images produced are blurred, rest them.

9. In reading, a book should not be held *nearer to the eyes* than is necessary to see the print distinctly. Print like that in the text of this book should not be read continuously nearer than about *eighteen inches.* If you are obliged to hold it nearer than fifteen inches, the probability is that you are near-sighted; if two feet away, far-sighted.

10. If the eyes ache or are weak, bathe them frequently in clear cool water, but do not use eye-washes, soap, poultices, or other application unless prescribed by a physician. The eye is too precious an organ to be trifled with.

11. "Have all diseases of the eye treated early and skilfully, and remember that the well eye sympathizes with the diseased one, and you may lose both unless early attention is given to the matter. Diseases of the eyes in which a large amount of matter forms are dangerous, and patients so affected should be careful to get no matter from the diseased eye into the well one, and they should have a separate basin and towels for washing purposes."

12. If necessary to wear glasses or spectacles, do it, the eyesight being of more importance than personal appearance.

13. Beware of quack eye doctors, and travelling or street vendors of spectacles; neither have medical education or experience. Even plain colored glasses or goggles, used without proper advice, are likely to be injurious.

QUESTIONS.

1. What are the parts belonging to the eye, or auxiliary to its use?
2. Describe how the eyes are protected from injury, — by situation; the eyebrows; the eyelids; and the eyelashes.
3. What is the conjunctiva and its function?
4. Where, and of what use, are the tarsal cartilages? the Meibomian glands?

5. What are the functions of the eyelids?
6. By what are tears secreted, and how are they poured into and distributed over the eye, and discharged from it?
7. Of what use are the tears, and how is their secretion increased?
8. Describe the eyeballs.
9. Through which part of them does light enter, and through what media?
10. How many and what coats has the other or opaque part?
11. Describe the sclerotic coat, and how it is moved.
12. What gains admission to the eye through the sclerotic coat, and where?
13. Locate, describe, and give the use of the choroid.
14. Of the iris and pupil.
15. To what is the color of the eye due?
16. Where is the ciliary muscle?
17. Locate, describe, and give the functions of the retina.
18. Explain what is meant by the "blind spot"; by the "yellow spot."
19. Explain why the spokes of a rapidly revolving wheel seem to run together, and why a rapidly revolving torch gives a circle of light.
20. How may the retina of the eye become tired and cease to act? and how may its action be restored?
21. Locate, describe, and give the use of the vitreous humor; of the crystalline lens.
22. In what position are the images of objects thrown upon the retina? Why do we see them in their proper position?
23. What is the ultimate organ of perception, and to what are unusual visions due?
24. Where and what is the aqueous humor?
25. What do you mean by the "circle" or "field of vision"?
26. What by the "power of accommodation," and to what is it due?
27. What illustrations can you give of the effect of training the power of accommodation?
28. What is the object of the optic nerves.
29. At what point does a decussation of the optic nerves take place?
30. How is the iris stimulated to contract and dilate?
31. What is meant by binocular vision, and what is its use?
32. What is meant by an emmetropic eye?
33. What is myopia, and to what is it due?
34. What bad habits produce it, and by what sort of glasses must it be relieved?

35. What is hypermetropia, and to what is it due?
36. What is presbyopia, and to what is it due?
37. How are hypermetropia and presbyopia remedied?
38. What is astigmatism, and to what is it due?
39. What is color-blindness and its dangers?
40. What cautions must be observed in reference to the care of the eyes?

ANALYSIS OF THE SEVENTEENTH CHAPTER.

SIGHT.

- I. Importance.
- II. Organs (or, the eyes and their appendages)
  - Orbit.
  - Eyebrows.
  - Eyelids and conjunctiva.
  - Eyelashes or ciliae.
  - Meibomian glands and ducts.
  - Eyeball
    - Cornea.
    - Sclerotic coat.
    - Choroid.
    - Iris.
    - Pupil.
    - Ciliary body.
    - Retina.
    - Vitreous humor.
    - Aqueous humor.
    - Crystalline lens.
  - Optic nerves.
- III. Normal
  - Binocular vision.
  - Power of accommodation.
- IV. Defects
  - Blurring, or weak sight.
  - Myopia, or short sight.
  - Hypermetropia, or long sight.
  - Presbyopia, or old sight.
  - Astigmatism.
- V. Care of.

CHAPTER XVIII.

HEARING.

392. *Hearing* is effected by means of impressions made by the vibration of elastic bodies, ordinarily of the atmosphere, upon the organs of hearing.[1] A shock from a sounding body, communicated to the surrounding atmosphere, passes in waves towards the ear, moving like the ripples upon water after a pebble has been thrown into it. Sound moves at the rate of 1090 feet per second in air at the freezing point; the velocity increasing 2 feet per second for every increase of 2° C. in the temperature.

Upon the variations in the rapidity of the vibrations of sonorous bodies depends the *pitch* of the sounds they produce. Every sound is composed of a number of partial tones, as they are called, just as light is composed of a number of colors. The number and comparative strength of these partial tones affords the difference in sounds.[2] By this difference we distinguish one voice from another. The notes on the piano and organ are said to vary from 33 to 4224 vibrations in a second. The piccolo, a kind of flute, emits a shrill note of 4752 vibrations in a second. These are the ordinary notes used in music, but the human ear can distinguish a note with as few vibrations as 20, and as many as 38,000, in a second. The higher notes,

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[1] The earth, wood, and many other solid substances transmit sound readily. Even so slight a sound as the scratching with a pin on the end of a long log may be heard at the other end. An approaching train may be discovered by the sound transmitted for a long distance upon the iron rails.

[2] The first partial tone is known as the fundamental tone, the others are "over-tones" or harmonics.

however, are more or less painful to the ear, so powerful are the vibrations in the air of the auditory canal.[1]

393. *The ear is the organ of hearing.* It has a very complex and delicate structure, which is for the most part located in the petrous or stony portion of the temporal bone in order to be well protected from injury. For convenience of study the ear is considered in three portions: the *external*, *middle*, and *internal ear*. The first two anatomical divisions correspond to the conducting apparatus, and the last to the perceptive.

394. *The external ear* includes the *auricle*, or the ear of common language, and the *auditory canal*, which leads to the *membrana tympani* or *drum-head*. The auricle is a shell of cartilage covered with skin, which closely fits its every groove, ridge, and depression. It flares out something like a funnel, the better to catch vibrations of sound. In man it is rarely movable, the muscles for that purpose not being large or well developed.[2] It is well supplied with blood-vessels, nerves, and lymphatics, and has at its lowest part a cushion of fat and fibrous tissue, being the part to which earrings are fastened.[3] The auricle gradually blends with the walls of the auditory canal. This canal is about one and one-fourth inches long, averages one-fourth inch in diameter, and has a downward, inward, and somewhat forward direction. The outer one-third is cartilage; the inner two-thirds, bone. Through this canal the drum-head which closes its lower end may be seen by means of

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[1] *Hearing and how to keep it.* American Health Primer. CHAS. H. BURNETT, M.D.

[2] In animals the auricle in general is very movable, enabling them to perceive very faint sounds by turning the ear towards them. Even some human beings possess considerable power in this respect.

[3] Sometimes the cartilage dips down into the lobule and is liable to injury when the ear is pierced. Serious inflammation may thus be produced.

a reflecting mirror and an instrument called the *ear speculum.* The walls of this canal are lined by skin which is continuous with that of the auricle, and also with that over the drum-head, where the skin is very fine. The external ear has in the auditory canal an abundance of both sweat and sebaceous glands, and many hairs, which

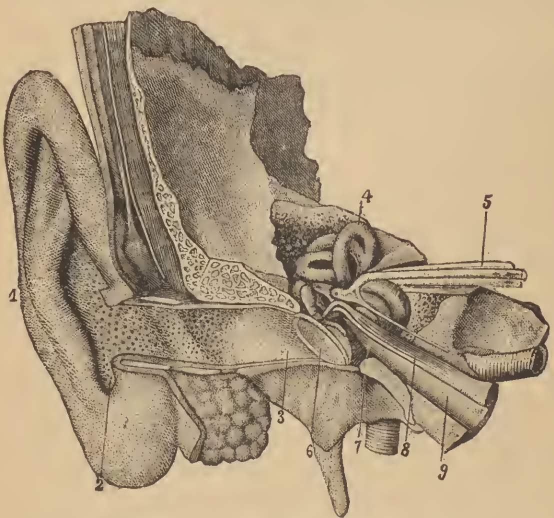

Fig. 85.

The organs of hearing. — 1, auricle; 2, opening of ear, showing orifices of sebaceous glands; 3, external auditory canal; 4, semi-circular canals; 5, auditory nerve, with facial nerve; 6, membrana tympani, with the elastic fibrous membrane which forms its border; 7, tympanic cavity; 8, tensor muscle of the tympanum, the tendon being attached to the upper portion of the handle of the malleus; 9, upper portion of Eustachian tube.

are coarse and stiff; also numerous ceruminous or wax-producing glands,[1] which secrete the wax of the ear, a sticky and bitter substance which tends to prevent the inroads of insects and the growth of fungi.

395. *The drum-head* or *membrana tympani* (wrongly called *the drum*), at the bottom of the auditory canal, is

[1] They are classified as modified sweat glands.

the partition between the external ear and the middle ear or drum cavity. It is almost circular, about one-fourth of an inch in diameter, and $\frac{1}{250}$ of an inch thick, and consists of three layers: an outer one of skin, a middle one of fibrous tissue (to which the other layers are attached), and an inner one of mucous membrane, continuous with the lining membrane of the drum cavity, and with that of the Eustachian tube and the pharynx. Near the central line of the drum-head, and extending from above downward and backward, as seen through the external opening of the ear, is an opaque, white ridge, due to the attachment of the so-called handle of the hammer, one of the small bones of the ear, to the middle layer of the drum-head. So attached, the hammer readily vibrates inwards and outwards with the vibrations of the drum-head. The general surface of the drum-head is smooth and of a pearly lustre.

396. *The middle ear*, tympanum, or drum proper, is an air cavity,[1] about one-half inch in height and width, and about one-fourth of an inch deep, and is lined with mucous membrane, a continuation from that of the throat, through the Eustachian tube, which tube connects the drum cavity with the pharynx. Connected also with this cavity posteriorly, and lined with mucous membrane, are the "mastoid cells" or little air cavities in the mastoid portion of the temporal bone,[2] — the prominence immediately behind the auricle. Through these cells, or through the roof of the drum cavity, which is very thin, and upon which the brain rests, an inflammation of the middle ear may extend to the brain.

[1] This cavity or drum in its construction somewhat resembles an ordinary snare or military drum, which is a reservoir of air, with two drum-heads capable of vibration. In an ordinary drum air is admitted to the inside (drum cavity) by holes in the sides of the drum. Into the drum of the ear the air is admitted through the Eustachian tube.

[2] Supposed to be concerned in the resonance of the voice.

The most important contents of the drum cavity are the three ossicles or little bones of the ear; viz., the *malleus* or hammer, the *incus* or anvil, and the *stapes* or stirrup, so named from a resemblance to these objects. Though weighing but a few grains, these bonelets have muscles, cartilages, and blood-vessels, and are so joined together that they form a bridge or "chain of bones" reaching across the drum cavity, from the drum-head to the internal ear, and by vibratory motion *convey sounds to the fluid of the internal ear*, in which float filaments of the auditory nerve. The bone nearest the drum-head, and the largest of the three, is the hammer, which is held in position by ligaments attached to the roof and outer wall of the drum cavity. Its handle is, as we have seen, fastened securely to the middle layer of the drum-head, while its head is articulated with the next bone, the anvil, which is also held in position by two ligaments, one attached to the upper and posterior wall of the drum cavity, and the other to the drum-head. If the handle of the hammer is pulled outwards, this joint between the hammer and anvil "unlocks," releasing the anvil, but if it is pushed inwards, the anvil is carried with it. The anvil is joined to the stirrup or stapes, its long process or leg fitting into a depression in the head of the stirrup. The foot-rest of the stirrup is oval, and accurately fits into the oval window of the labyrinth, as the cavity of the internal ear is called.

397. *The Eustachian tube* is a little more than an inch and a half long, and its direction from the mouth to the ear is upward, outward, and backward. Two-thirds of the lower portion of the tube is cartilaginous, while its upper wall is membraneous. The remainder of the tube is bone. In the act of swallowing, the anterior wall is pulled apart from the posterior by muscle fibres, offshoots from the

muscles of the palate, and air enters the Eustachian tube.[1] Attached to the drum-head is a delicate prolongation of one of these offshoots, known as the *tensor tympani*, or stretcher of the drum. This tube supplies air to the drum cavity, is an escape tube for its secretions, and is a passage for a counter equalizing current of air, when the drum-head is driven suddenly in by the concussion of a blow or explosion.[2] Gunners, when a heavy cannon is about to be fired, open their mouths so that the force of the concussion may be less felt, and they sometimes stand upon tiptoe for a similar reason.[3] Closure of the Eustachian tube is liable to cause deafness by preventing free entrance and exit of air, and by the consequent increased pressure upon the drum-head.

398. *The internal ear* comprises the *labyrinth* and portions of the auditory nerve connected with it. The labyrinth is a hollow bony cavity. Its central portion, called the *vestibule*, is a sort of ante-room, the entrance to which, from the middle ear (*i.e.* the oval opening or window), is closed by the foot-rest of the stirrup bone. Its upper and forward portion, the *cochlea* or *snail shell*, is a tube coiled in a pyramidal way. Its lower and posterior portion constitutes the *semicircular canals*, three in number. The inside of the cochlea is divided into two passages or stairways, one above the other, and connecting at

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[1] Repeated acts of swallowing are said to prevent much of the discomfort and pain in the ears consequent upon going down in diving bells, and ascending mountains.

[2] "At certain points on the Rhine, it is, or was, the custom of the captain of the steamboat to fire a small cannon to exhibit the echo. When this has been done without due warning, it has proved more than once a cause of lasting deafness."

[3] If, while a bather's head is immersed, two stones or shells be clashed together under the water, the sounds perceived by him will be almost deafening, and may permanently impair his hearing. Children should be extremely careful not to play this dangerous trick upon each other.

the upper portion of the cochlea. The lower part of the upper one opens into the vestibule near the oval opening or window, while the round window which is closed by a membrane, is near the corresponding part of the lower stairway. When the liquid in the labyrinth is compressed by the pressure inwards of the stirrup, it finds a point of relief at the round window, by the slight yielding of its membrane which occurs. The fluid which fills

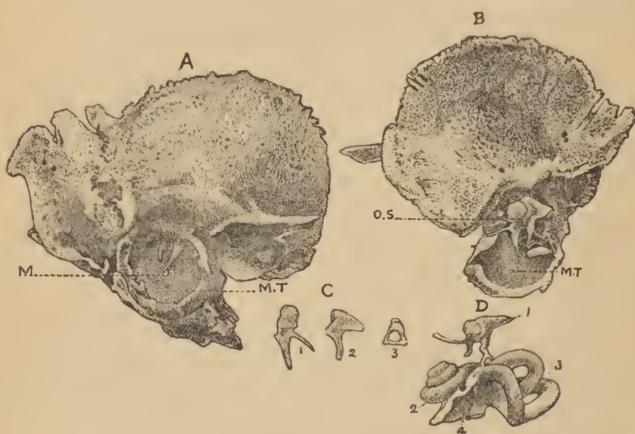

Fig. 86. (From photograph by RUDINGER.)

A. Right temporal bone, auricle and external canal removed. — MT, membrana tympani, or drum-head; M, handle of malleus showing through.
B. Right temporal bone, inner side, petrous portion removed. — MT, the drum-head; OS, chain of bones in position.
C. The bones of the ear. — 1, the malleus; 2, the incus; 3, the stapes.
D. The relation of the bones of the ear to the bony portions of the internal ear.— 1, the ossicles, foot-rest of stapes, attached to oval window; 2, the cochlea; 3, the semi-circular canals; 4, the upper end of Eustachian tube. The round window is not seen in the cut.

the labyrinth is a part of the natural water of the brain and skull cavity. In this fluid float membraneous casts of the labyrinth, called the *membraneous labyrinth*. Distributed in and upon them are the delicate filaments of the auditory nerve. Of this nerve there are two main branches, — the cochlear branch supplying the cochlea, and the vestibular branch supplying the remaining portion of

the membraneous labyrinth. The filaments of the cochlear nerve are distributed in a very complex manner to the shelves of the cochlea, and end upon thousands of little hair-like cells, harp strings as it were, which are held in place upon the so-called organs or arches of Corti.[1] The vibration of these hair-like cells is communicated to their connecting nerve filaments, and thus to the auditory nerve and brain. It is stated by physiologists that we hear noises with the vestibule nerves, and music with the cochlear ones.

399. It is supposed that beside their connection with hearing, the semicircular canals have something to do with the *coördination of muscular movements.* Coördinate muscular movements appear to depend for their due performance upon a correct notion of our equilibrium or proper carriage of the body. Experiments upon birds and animals show that when these canals are injured, uncontrollable motions of the head ensue, followed by reelings and falls, and the inability to control the movements involved in walking or flying. But neither consciousness or the sense of hearing is impaired. Sometimes in persons with ear disease there occur similar manifestations on an attempt to walk, although in like manner consciousness is unimpaired. From the above circumstances some speak of a sense of equilibrium, and locate it in the semicircular canals.

400. The *physiology of hearing* is briefly as follows. Sound waves are collected and strengthened by the auricle.[2]

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[1] There are said to be about three thousand arches of Corti in the human ear, each one of which is tuned to respond to the various musical sounds.

[2] In the lower animals whose ears are very movable, the auricles are true collectors of sound. In man they are but slightly movable, and have to do with the quality of sound more especially, as any one can ascertain by gently pressing the auricle backward or forward when near a number of sounds, as of steam whistles, in a theatre, etc.

Passing down the external auditory canal, they strike the drum-head and cause it to vibrate and set in motion the ossicles, which in turn, through the foot-plate of the stirrup bone, impart motion to the water of the labyrinth. Through this fluid the impressions of the sound waves are conveyed to the membraneous labyrinth, and thence, by the filaments of the auditory nerve which lie upon the membrane, to the brain. To be able to hear accurately even ordinary sounds, and to be able to train the sense of hearing, it is necessary that there should be an accurate arrangement of the various portions of the auditory apparatus, free movements of muscles, membranes, and bones, of the fluid of the labyrinth, and of the air outside and inside the drum cavity.

401. *Defective hearing* may exist without the knowledge of the sufferer or of his friends. Of 570 school children examined in New York City,[1] 76 were found to be deficient in hearing, either in one or both ears, while only *one* had been known by the teachers to be deaf, and only 19 out of the 76 were aware of aural defects.[2] Neglected inflammations of the throat, especially in those living in an impure atmosphere, eruptive diseases, such as *scarlet fever* and *measles*, where inflammation extends into the Eustachian tubes, may give rise to deafness. Decayed teeth or inflamed gums, by reflex irritation through a ganglion near the ear, sometimes produce earache and

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[1] See circular of information of the Bureau of Education, No. 5. 1881.

[2] In conducting such tests the voice is considered a better test than the ticking of a watch. The examined, having one ear stopped by an assistant while the other ear is being examined, should stand with closed eyes at various distances from the examiner. The sentences repeated should be intelligible and frequently changed, and should contain words with hissing and guttural sounds, these not being easily understood when hearing is impaired. Though this mode of testing is the best, it is not as accurate as the test for defective vision.

temporary deafness. *Blows upon the ear, always dangerous, may cause temporary or permanent deafness.* Accumulation of ear wax is a very common cause of deafness.[1] Cleaning the ear too frequently with swabs, or the clearing out of wax with pin-heads, hair-pins, and other metallic implements, will be apt to excite inflammation,[2] and may facilitate the growth of fungi. Neglected diseases of the middle ear may result in brain disease, by inflammation through the mastoid cells. Ear diseases may produce ringing and hissing sounds in the ear, which are very annoying. In certain forms of disease the individual's own voice sounds loud and disagreeable to him.

402. *Care of the ears.* To prevent catching cold in the ears, they should be frequently but gently washed, and in very cold weather may be protected by covering with a loosely-fitting cap, tippet, or ear tabs. Pressure or overheat will increase the perspiration, and soften the skin. Draughts of air from open windows in fast-moving trains should be avoided. Excessive smoking, or the habit of breathing through the mouth, are injurious, as they dry the mucous passages of the ear, and thus interfere with hearing. Improper clothing, overheated rooms, wet feet, etc., may cause inflammation of the ear. Prolonged bathing in cold water, or diving from a height, are to be

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[1] The number of people is very large who apply at the eye and ear infirmaries for relief from deafness, and who obtain it after accumulated ear wax has been removed.

[2] The habit of probing and scraping the external ear is injurious ; it excites the ceruminous glands to pour out a superabundance of wax, which impairs hearing, and is an annoyance to those who desire to appear cleanly. A graver harm also may be done, such as wounding the delicate lining of the ear, or puncturing the drum membrane, or displacing the little bones. The best way to cleanse the external ear is to carefully inject warm water, or warm water with a little good soap dissolved in it, without any scraping, and little or no swabbing. Any substance which cannot be easily removed by syringing had better be left to the care of a physician.

avoided. When about to dive, or swim under water, a pledget of cotton in each ear is advisable, but the prolonged wearing of cotton in the ears makes them sensitive.

QUESTIONS.

1. How is hearing effected?
2. What do you mean by the intensity of sound? the pitch? the quality?
3. What can you say of the capacity of the ear to distinguish different sounds?
4. What is the organ of hearing, and under what divisions is it studied?
5. What does the external ear comprise?
6. Describe the auricle and its use.
7. Describe the auditory canal.
8. What glands are located in the external ear, and what in the auricle?
9. Describe the *membrana tympani* or drum-head.
10. What is seen on looking at the drum-head by means of proper instruments?
11. What is the middle ear, and what does it comprise?
12. Where are the mastoid cells?
13. Describe the contents of the drum cavity.
14. How do the small bones of the cavity, and the fluid of the labyrinth, act to enable us to hear?
15. Describe the Eustachian tube and its uses.
16. What is the effect of its stoppage?
17. What does the internal ear comprise?
18. Describe the labyrinth, and its several divisions and contents.
19. What is distributed throughout the labyrinth to convey the auditory impressions to the cerebrum?
20. What is the belief of physiologists as to the function of the semicircular canals, and on what is this belief founded?
21. Explain how it is that we hear, and what is essential for accurate hearing.
22. What may be said as to the prevalence of defective hearing, and to what causes in general is it due?
23. What are some of the consequences of ear diseases?
24. What care should be taken of the ears, and what precautions used?

ANALYSIS OF THE EIGHTEENTH CHAPTER.

HEARING.

- I. Sound
  - How produced.
  - Pitch.
  - Composition.
- II. Organs (or the ears and their appendages)
  - External ear
    - Auricle.
    - Auditory canal.
    - Sweat glands.
    - Sebaceous glands.
    - Ceruminous glands.
    - Hairs.
  - Middle ear or drum
    - Drum-head, or membrana tympani, and its appendages.
    - Drum cavity and its contents
      - Hammer or malleus.
      - Anvil or incus.
      - Stirrup or stapes.
    - Eustachian tube.
    - Mastoid cells in mastoid portion of the temporal bone.
    - Muscles, nerves, and ligaments.
  - Internal ear
    - Labyrinth
      - Vestibule.
      - Cochlea.
      - Semicircular canals.
      - Fluid.
      - Membraneous casts.
      - Arches of Corti.
    - Auditory nerve
      - Cochlear branch.
      - Vestibular branch.
- III. Physiology of.
- IV. Defects and Preservation.

CHAPTER XIX.

THE VOICE.

403. All animals, except the very lowest types, possess some audible method of communicating with their fellows.[1] Some are incapable of producing more than one kind of sound, — a monotonous cry, — while the sounds emitted by others admit of considerable variation. The dog's notes of welcome to his master are very different from the harsher sounds with which he greets intrusive strangers. *But to man alone is it given to express thoughts in articulate sounds, or speech.* Between the higher and lower races of mankind there is a great difference as to the use of the voice, both in language and song, and its development is usually in direct relation to the intelligence of the races. Idiots, notwithstanding their possession of a normal vocal apparatus, cannot usually converse intelligibly, but resemble some of the lower animals in the character of their vocal sounds. Parrots and other

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[1] Among insects this is sometimes accomplished by the rapid vibrations of wings, the tapping of antennae or limbs upon some resonant object, or the rubbing of hard portions of the body against each other, the leg against the wing, for instance, as in the locust family. In some beetles the sound-producing organ is a kind of "rasp," and moves upon an adjoining surface. The peculiar voice of the "death-watch" beetle is produced by the insect raising itself on its legs and striking its chest against adjoining wood. This weird sound is referred to by Gay: "The solemn death-watch click'd the hour she died." Sir John Lubbock claims that bees can vary their hum so as to express their feelings. Certain fishes are said to produce sounds almost musical in character, by means of muscles which control the "swimming bladder," or by other apparatus. The common domestic fowl emits one kind of sound when quietly employed in scratching for food, and another when a hawk approaches. The crane has a marvellously constructed trumpet, for use especially at night and when taking long flights.

birds can be taught, by constant repetition, to repeat difficult words and sentences, and to imitate cries, laughter, and sobbing; but they do not originate, as far as we are aware, words or sentences, or any articulate expressions of the emotions. The development of speech is intimately connected with the acuteness of the special senses, for it is through them that we gather impressions which develop into ideas, and thence into language. This is especially true of the hearing. It is only by persistent and pains-taking efforts, that some who have been born deaf have been taught in some degree to articulate and even converse, but, of course, without that delicate modulation of tone and accentuation and emphasis of words, which can only be given by a regulating ear. And the limited power thus laboriously acquired is, after all, exceedingly precarious and easily lost. (*a.*)

404. The *parts concerned in the production of voice* include the special or essential organ of the voice, the larynx, (Fig. 61), and as accessory, the windpipe, lungs, respiratory muscles, pharynx, mouth, and the nasal cavities. All of these parts are necessary for the proper modulation of the voice. The mechanism required for its production may be compared to that of a reed organ, the lungs corrresponding to the bellows which supply air, the bronchial tubes and trachea to the wind chest which conducts the air, the larynx, with its vibrating cords, to the vibrating reed of an organ, and the pharynx, mouth, and the parts in connection with them, to the body tube or resonant pipe which modifies the sounds produced.[1]

405. The *larynx* is situated in the middle and front part of the neck, and at the upper end of the trachea. It

[1] The author is indebted to the works of Dr. Elsberg of New York, and of Dr. Cohen of Philadelphia, for some of the definitions and suggestions in the text.

is somewhat triangular in shape, and from its resemblanee to a box, it is sometimes spoken of as the "voiee-box." Its framework is eartilaginous, and is lined with mueous membrane, eontinuous with that of the pharynx and windpipe. This framework is eomposed mainly of four eartilages (Fig. 34) joined together. The largest of the four is the *thyroid*, or shield eartilage, a broad, thin plate, shaped something like a eover of a half-open book, and joined to the hyoid bone above by a membrane. The baek of the book represents the ridge of the thyroid eartilage, as seen or felt in front of the neek, and familiarly known as Adam's apple. Below the thyroid eartilage, and attaehed to it by an eneireling membrane, is the seeond of the four, or the *cricoid*, whieh is shaped like a seal ring, with the narrow portion in front. Lastly, upon the posterior and upper surface of the erieoid are two slight eminenees for artieulation, by ball-and-soeket joints, with two pyramidal and very movable eartilages, ealled the *arytenoids*.[1]

Surmounting the arytenoid eartilages are two very small ones, known as the supra-arytenoids or buffer eartilages, whieh deaden and distribute pressure, and serve to prevent injury to the larynx, espeeially in swallowing. Attaehed by its lower and narrow end to the inner and upper part of the thyroid eartilage is the *epiglottis*, or eover cartilage, shaped something like a lilae leaf, whose prineipal funetion it is to assist in preventing the entranee of food or other artieles into the larynx during the aet of swallowing. At sueh times the larynx is raised, its walls are approximated, and the epiglottis, as a lid, eovers the opening of the glottis. On looking into the throat during a full inspiration, the rounded, free, and upper edge of the epiglottis is sometimes visible behind the base of the tongue. Within

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[1] *I.e.*, like a pitcher, so called because when joined together they resemble the beak or mouth of a pitcher.

the folds of the mucous membrane, stretching from the epiglottis to the arytenoids, are two other cartilages, long and sickle-shaped, termed "prop" cartilages, which assist in keeping the larynx open.

406. In the production of voice *the vocal cords and the muscles of the larynx are most intimately concerned.* The interior of the larynx has on each side, at about its centre, a pair of membraneous and horizontal projections, with free borders, called the superior and inferior *vocal cords*, or *bands*.[1] The space between the right and left vocal cords is the "chink" of the glottis, and that between each superior and inferior band, the ventricle. The vocal cords are stretched across the larynx from before backward. The upper, or superior pair, are mere folds of membrane. They are less prominent and more inelastic than the inferior, and are called the ventricular bands, or *false vocal cords*, because they are not concerned in the production of voice. The inferior, or *true vocal cords*, have elastic borders, which are attached in front to the angle in the thyroid cartilage, just below the attachment of the epiglottis, and are there comparatively immovable, while posteriorly they are attached to the very movable arytenoid cartilages.

407. It is by the contraction and relaxation of these inferior cords or bands that the opening of the glottis is enlarged or diminished in size during respiration, and for the production of voice.[2] The tension and degree of

[1] The term "cord" in common use is misleading, for the vocal cords are not strings like those of the piano or harp, but horizontal ligamentous bands. Their arrangement allows the edges or margins to be sharply defined and to vibrate more or less as the air passes over them.

[2] "You know musical chords or strings, as those of the guitar, violin, etc., are attached only at their two ends, so that they can freely vibrate between; the tongues or reeds of organs, accordeons, clarionettes, and all other artificial reed instruments, are usually attached at one end only, so that they have three

approximation of the cords is variously modified through muscles, and thus is produced in part the various differences of sound which make up the human voice. Some of the muscles of the larynx move and rotate the arytenoids outwardly, thus separating the vocal cords, and widening the chink of the glottis. Others move and rotate the arytenoids inwardly, thus approximating the vocal cords, and, in a varying degree, closing the glottis. The remaining muscles of the larynx serve either to regulate the tension of the cords, or are concerned in respiration, or act upon the epiglottis during the act of swallowing. The nerves which supply the mucous membrane of the larynx with

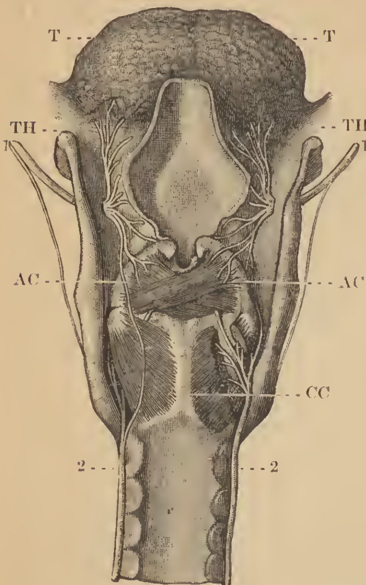

Fig. 87.
Posterior view of larynx. — T, base of tongue. TH, upper part of thyroid cartilage (the epiglottis is seen between the upper portions of this cartilage and behind the tongue. CC, the cricoid cartilage. AC, arytenoid cartilages, hid in part by muscles. TR, trachea. 1 and 2, nerves of larynx, branches distributed to the tongue, to the epiglottis and the folds of membrane between the epiglottis and arytenoids; and to muscles controlling the action of the cricoid and arytenoid cartilages.

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free edges; but the human reeds or vocal bands are attached on three sides and have only one free edge. Those of you who know what a large number of reed or organ pipes are needed in the organ made by man, to produce the notes of varying pitch and timbre, cannot fail to be struck with astonishment at the fact that in the organ in man's body a single reed-pipe, the larynx — by a wonderful power of variation inherent in itself — suffices for the production of the most various sounds. No musical instrument has ever been constructed by man that approaches in perfection or effectiveness that of the human voice." — *The Throat and its Functions.* Louis Elsberg, A.M., M.D.

sensibility and the muscles with motor power are four in number.

408. Before the introduction and use of the laryngoscope there was much uncertainty as to the mechanism for the production of voice.[1] An examination of the interior of the larynx with this instrument during ordinary respiration shows the chink of the glottis to be quite widely open during inspiration, but much narrower during expiration, for in the latter case the muscles of the larynx are passive, air being gently forced out. But it is during vocalization that the vocal cords are particularly well defined. Speech is shown by the laryngoscope to be effected during expiration only, though harsh sounds may be formed during inspiration. As soon as an attempt is made to produce a sound, the cords are thrown into action. They are made tense, and are closely approximated in the production of high musical notes or shrill sounds, and are relaxed and moved further apart during the emission of sounds opposite to these.

Fig. 88.
View of the interior of the larynx during respiration. Rings of the trachea seen through the laryngeal opening, the vocal cords (represented in white) being apart.

409. Associated with the varying degree of approximation and tension of the cords are their vibratory motions as the air passes between them. All sounds are produced

[1] An oval or round mirror attached to a long handle, which, placed in the back and upper part of the throat reflects the interior of the larynx, and, under favorable conditions, a portion of the trachea. This instrument originated from the observations of the celebrated singing teacher, Garcia, upon himself, and the investigations of two Austrian physicians, Turck and Czermak. The first successful demonstration of the action of the vocal cords is said to have been made by Garcia in 1854.

by wave-like vibrations of the air imparted to it by vibratory motions of various kinds. Noises, for example, are produced by waves of sound which follow one another in an irregular and confused manner, while in music the sequence is regular, producing the rhythmical sounds known as musical notes.[1] For the production of the simplest vocal sound the cords must be brought into close approximation, and must be capable of easy vibration. If they cannot so approach each other, whispering results. If they are not sufficiently smooth or straight, or if their action is irregular, or they have upon their edges flakes of mucus, the tones become rough and hoarse in character.[2]

Fig. 89.
The position of the vocal bands during phonation.

410. The *variations in vocal sounds* depend mainly upon their *intensity*, *pitch*, and *quality*. Intensity, or loudness, depends upon the elasticity of the vocal bands and the force of the escaping air. The more relaxed the bands are, and the stronger the current of air over them, the larger are the sound-waves, and the louder the sounds produced.

Differences in pitch depend upon the rapidity with which the bands vibrate. The more rapid the vibrations, and the closer the cords are approximated, the higher the

[1] The tones or notes of musical instruments are caused either by striking or rubbing with a bow against sharp edges, or by blowing against elastic tongues or vibrators. The character of the tones produced depends upon the nature of the stroke, the place struck, and the relative density, rigidity, and elasticity of the edge or tongue.

[2] The varying tones produced through elastic bands more or less parallel with each other, and with edges of varying rigidity, may be illustrated by blowing through glass tubes of varying length and calibre, to the opposite ends of which two pieces of thin rubber cloth are firmly fastened, the free edges being parallel or nearly so.

pitch. The slower they are, and the less closely the cords approximate, the lower the sound.

The quality, or timbre, is that characteristic by which we can distinguish different voices. Through this the voices of our friends are recognized even though their features may be concealed. As the violinist becomes attached to a certain violin because of its peculiar tone, or the pianist to his piano, so we learn to value the quality of certain voices. *Quality* is of a composite nature, and is due to the more or less harmonious relations between intensity, pitch, and other characteristics of sound, and depends largely upon the condition of the resonant cavities of the throat, mouth, and nose. Enlarged tonsils, loss of teeth, dryness of the mucous membrane, cleft palate, hair lip, and other defects, change the quality of vocal sounds. Our vowel sounds are clearly enunciated only when the sounding breath is not obstructed above the larynx in its outward passage. With the mouth wide open, only an aspirate sound can be made by the vocal bands. Consonant sounds result when there is an obstruction by the lips, tongue, teeth, etc., to the outward motion of the air. The position of the tongue and of the soft palate favor the emission of certain sounds. A "nasal twang" is the result of talking, or of emitting sounds, with the nose or the passages thereto, from the lungs, more or less obstructed. It is not so much because we talk through the nose, as because we do not use the nasal vent with sufficient freedom. It is called a "nasal twang," therefore, because the closed or contracted nasal apertures have caused the unpleasant modification of the sound. The different qualities of voice depend not only upon natural variations in the larynx and the accessory organs of the voice, but also upon the degree of culture or of neglect and abuse to which the voice and its organs have been

subjected.[1] By proper training the quality of the voice may be very much improved. In some persons it is so perfectly modulated, that, while the voice is full and clear, it never seems too high, too low, too harsh, or too flat.[2] There is also a property of voice known as *reach*, *i.e.*, "the penetrant power of a sound over distances and obstacles, such as other sounds, and is due to the purity of the tone, which in its turn is dependent on the accuracy with which it is produced." At the Peace Jubilee in Boston, in 1869, Madame Parepa Rosa's voice was distinguishable above those of an accompanying chorus of nearly 12,000 singers, an orchestra of over 1,000 instruments, and in a hall where the audience consisted of over 40,000 people. The ordinary *range* or *compass* of *the voice* is about two octaves, seldom less than one, or more than two and a half. In some great singers the range is three or three and a half.[3]

411. The peculiar mode of speaking known as *ventriloquism* is a curious modification of the voice, and is not, as the word literally means, "talking from the stomach."

[1] Among the Greeks for the training of the voice there were three sets of teachers, the first to develop power and range of voice, the second to improve the quality, the third to teach modulation and inflection.

[2] The capabilities of some voices are almost incredible. It is related by Mrs. Seiler, in her manual on "The Voice in Singing," that the singer, Farinelli, once competed with a trumpeter who accompanied him in an Aria: "After both had several times dwelt on notes in which each sought to excel the other in power and duration, they prolonged a note with a double trill in thirds, which they continued until both seemed to be exhausted. At last the trumpeter gave up, entirely out of breath, while Farinelli, without taking breath, prolonged the note with renewed volume of sound trilling, and ending finally with the most difficult of roulades."

[3] "The entire compass of the human voice exceeds five octaves, for there have been bassos, as Grosser, Fischer, etc., who could sing the contra F of 40 vibrations with ease and power, and sopranos like Carlotta Patti and Christine Nilsson go up with ease to the high F of 1400 vibrations, while the 'Bastardella' and Mrs. Becker of St. Petersburg could go up to and beyond the still higher C of 2000 vibrations." — *The Throat and its Functions*. ELSBERG.

The power of the ventriloquist is sufficiently marvellous without our deriving it from a still more marvellous source. By some occult management of the vocal organs, by great skill in mimicry, and by considerable address in appealing to the imagination, different human voices, or animal cries, or other noises, are caused by the ventriloquist to seem to issue from persons or objects outside of him, or from a distance, without his apparently moving his lips. It is this remarkable power which will doubtless account for many of the wonderful responses which are said to have been made by the ancient oracles.[1]

412. The chief *varieties* of voice are four in number; viz., the bass and tenor in the male sex, and the contralto or alto, and the soprano, in the female. There is a variety of voice between the bass and tenor known as the baritone, and one between the alto and soprano called the mezzo-soprano. Ordinarily the strength and beauty of bass and contralto voices are in the lower notes, and of soprano and tenor in the higher, for bass singers may reach as high notes as tenors, and alto singers as sopranos, or vice versa, but they do not attain the proper clearness and richness of tone. A falsetto voice is one pitched above its natural compass. In early childhood the character of the voice is about the same in both sexes. The quality especially of

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[1] "From the observations of Müller and Colombat, it seems that the essential mechanical parts of the process of ventriloquism consist in taking a full inspiration, then keeping the muscles of the chest and neck fixed, and speaking with the mouth almost closed, and the lips and lower jaw as motionless as possible, while air is very slowly expired through a very narrow glottis, care being taken, also, that none of the expired air passes through the nose. But, as observed by Müller, much of the ventriloquist's skill in imitating the voices coming from particular directions, consists in deceiving other senses than hearing. We never distinguish very readily the direction in which sounds reach our ear; and when our attention is directed to a particular point, our imagination is very apt to refer to that point whatever sounds we may hear." —*Handbook of Physiology*. KIRKE.

the soprano voice in boys is often prized in the rendering of church music. At about the age of fourteen years the boy's voice begins to change, or "crack" as it is called. The larynx increases in size, the power of regulating its muscular control is diminished, and the falsetto voice is liable to break in upon the ordinary voice, especially in declaiming and singing. The voices of girls at about the same age change somewhat. They develop strength and compass, the quality remaining about the same. But with both sexes at this period *there should be no systematic cultivation of the voice.*

413. *Weak and improperly modulated voices can be improved by proper care and culture.* To this end all diseased conditions, such as enlarged tonsils, a very relaxed soft palate, nasal or pharyngeal catarrh, defective teeth, etc., should be remedied, and also muscular exercises adapted to the wants of each individual, should be systematically practised. The muscles of the diaphragm, and those of the chest, may be exercised by occasional full respirations, and by the hands being placed from time to time against a wall, and the chest moved forcibly towards and away from the wall. "The muscles of the larynx are best exercised by systematic singing exercises on the tones at or near the middle of the ordinary compass of the individual." Repetitions of the act of swallowing, and various movements of the lips, cheeks, and tongue, are valuable. Wind instruments adapted to the strength of the performer are also of service in some instances. If they are too powerful, or are used excessively, injury to the lungs is liable to result. In particular the voice should be frequently used in a natural and proper manner. Spasmodic and prolonged use, especially if the voice is pitched too high, strains the vocal apparatus, and produces inflammation of the mucous membrane of the throat. The forced and unnecessary res-

pirations, especially of the chest or thoracic variety, sometimes indulged in by public speakers and singers, place the thorax and larynx in tiresome and constrained positions, thus interfering with the natural use of the voice, and serving to concentrate the thoughts upon the delivery alone. In fact the training of the voice should begin in childhood, when the vocal organs are most pliable. It should be entrusted to competent teachers, and like other forms of muscular exercise should be systematically and daily pursued, but never to the point of tiring. It is related of a celebrated musician that, in answer to an inquiry why he practised so systematically, he replied, "If I neglect to practise one day, I notice it; if for two days, my friends notice it; and if for three, the public notice it."

Even in adult life, the strength and quality of the voice may be improved, and clergymen, actors, and other public speakers have had their usefulness increased by lessons received quite late in life in elocution and the care of the voice. (*a.*)

QUESTIONS.

1. What is to be said of the audible means of communication of animals and men, and on what does its development depend? Illustrate.
2. With what is the development of speech intimately connected? Illustrate.
3. What parts of the body are concerned in the production of voice?
4. Which is the special or essential organ of voice?
5. Describe the larynx, its cartilages, vocal cords, and muscles.
6. How are the differences of sound which make up the voice produced?
7. How has the mechanism for this purpose been ascertained?
8. What does an examination of the interior of the larynx with the laryngoscope reveal?
9. How are sounds produced, and why are some sounds musical and others not?

10. What causes the differences in their intensity? pitch?
11. What is the quality of a voice, and on what does it depend?
12. What is ventriloquism?
13. What is reach?
14. What is said of the range or compass of the human voice?
15. What are the chief varieties of voice?
16. How and when do the voices of boys and girls change?
17. How is the voice modulated to produce the various articulate sounds?
18. What is to be said of nasal sounds? of clearness of voice?
19. What general directions are there for the care and culture of the voice?

ANALYSIS OF THE NINETEENTH CHAPTER.

THE VOICE.

- I. Object, and among whom most developed.
- II. Organs
  - Essential,— Larynx
    - Cartilages . . .
      - Thyroid.
      - Cricoid.
      - Two arytenoids.
      - Two supra-arytenoids.
      - Two prop.
      - Epiglottis.
    - Vocal cords . .
      - Superior or false.
      - Inferior or true.
    - Chink of the glottis.
    - Muscles and nerves.
    - Action and how examined.
  - Accessory
    - Lungs.
    - Respiratory muscles.
    - Air passages
      - The trachea.
      - Pharynx.
      - Mouth and its contents.
      - Nasal cavities.
- III. How Produced.
- IV. Sounds . .
  - Harsh and musical.
  - Intensity. Pitch. Quality.
  - Articulate
    - Natural.
    - Obstructed.
- V. Reach.
- VI. Range or Compass.
- VII. Ventriloquism.
- VIII. Varieties
  - As to age
  - As to sex
    - Male. . . .
      - Bass.
      - Baritone.
      - Tenor.
    - Female .
      - Alto.
      - Mezzo-soprano.
      - Soprano.
  - Falsetto
- IX. Care and Culture.

EMERGENCIES.

CHAPTER XX.

EMERGENCIES.

THE following directions as to the care of the injured are intended to increase the efficiency of those who may wish to assist them, and are of especial value to any one who has some knowledge of anatomy, physiology, and hygiene. It is to be understood that these directions are not full enough to enable the laity to undertake the prolonged treatment of a case, and that whenever it is practicable a physician is to be sent for and the injured person given into his charge. When called, the doctor should be informed of the nature of the accident, that he may bring with him the proper appliances and restoratives. Such directions as the following, carefully observed, will often save life. As Dr. D. Hayes Agnew of Philadelphia puts it, "every surgeon knows full well that in many cases of injury the crisis is reached before the patient arrives at the hospital gate, and the lack of instructed aid at first often turns the table against him." There have been instances also where officiousness on the part of some bystander has increased the danger of the injured person.[1]

GENERAL DIRECTIONS.

First. Do not join the crowd assembled about an injured person unless you can be of service; for, as the throng increases in numbers and presses more closely about the sufferer, his chances for recovery are lessened. His air supply is diminished, and the efforts of those assisting him are interfered with.

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[1] To replace officiousness with efficiency is the aim of the Esmarch Samaritan Schools in Germany, of the St. John Ambulance Association of England, and of such societies in this country as the Society for Instruction in First Aid to the Injured of New York and Brooklyn.

At least ten feet of space on every side of the injured person should be kept free from everybody, except those actually concerned in caring for him.

Second. When you withdraw, take as many idlers as you can with you. If no one has assumed charge of the case, take it in hand, going quickly but calmly to work; but, if there is already a leader, offer him your assistance, being willing to go for a doctor, blankets, stimulants, etc., or do whatever is desired. Do not argue with others who are assisting as to methods of work, for delay imperils the life of the one you desire to save. On the other hand, do not proceed too rapidly. For example, in the excitement of the moment, it not infrequently happens that attempts are made to administer stimulants before the injured person can swallow.

Third. The person before you may be partially or entirely unconscious. Unconsciousness is the result of injury to the brain by shock, compression from fracture of the skull, by apoplexy, epilepsy, or other disease of the brain, by narcotic poisons such as opium, morphine, chloroform, or alcohol, by loss of blood, or by blood poisoning, as in some forms of kidney disease. If there is entire insensibility, an arm when lifted and let gently fall offers no muscular resistance, but is "a dead weight"; the pupil of the eye does not contract on exposure to light; the eyeball itself is not sensitive when touched, and no effort even at closing the lids occurs when the operator's finger is brought quickly towards the eye. Whereas, if the unconsciousness is partial or is feigned, as in some cases of so-called hysteria, the conditions are opposite.

Fourth. Restoration to consciousness is effected differently, depending upon the case. In "faint" or "shock," a few minutes of rest may suffice, the patient being laid upon his back, with all impediments to free breathing removed. A dash of cold water upon the face, tickling of the nostrils, and the application to them of an open bottle of smelling-salts or ammonia (spirits of hartshorn) may be necessary. Intoxicated persons sometimes require more vigorous measures, such as

slapping of the face, tickling or slapping of the soles of the feet, and twisting of the hair. But it must be remembered that the effects of drink may be associated with severe forms of unconsciousness, and vigorous restorative measures applied to one insensible from apoplexy, or even shock, imperil life. Unconsciousness from suffocation may demand attempts at establishing respiration, to be hereafter described.

When the skin is cold, restore warmth by gentle friction with the hands, and applications of heated flannels and bottles filled with hot water, especially to the feet, about the body, and in the armpits. If the head is very hot, cold water or pieces of ice may be applied to it. The injured person generally needs abundance of air, and it may be necessary to create a current by the use of a fan; but, at the first evidence of chilliness, the patient should be covered with blankets, shawls, coats, etc., but not so heavily as to induce perspiration. If the person is able to swallow, give a sip, every few minutes, of a mixture of aromatic spirits of ammonia, thirty drops to a wineglassful of water, *or* of brandy or whiskey, one part to four or five of water. If wine be used, a much larger amount is necessary.

Fifth. The examination of an injured person, especially when insensible, is to be conducted with the greatest care. Rough handling may open a wound in which bleeding had ceased, and start a hemorrhage which may not be readily controlled, or a jagged end of a broken bone may be made to wound seriously an important blood vessel or nerve, or severe pain and distress may be otherwise induced. Note particularly the position of the body, whether the face is flushed or pale, whether the pupils respond to light, what is the state of the respiration, whether quiet and natural or more or less noisy or difficult, and the condition of the pulse whether weak or strong.[1]

[1] The condition of the pulse is indicated by the comparative ease or difficulty with which the flow of blood in an artery can be stopped by the pressure of the finger. Examine the entire body carefully in your search for fractures, wounds, unusual swellings, or depressions.

Sixth. To remove an injured person, use a stretcher, *i.e.*, a portable bed made for the purpose, or a strong shawl or sheet doubled and suspended between two poles, a wide board, a door, a window shutter, a ladder, or a small cot bedstead. If the distance is short, and a litter cannot be obtained, the patient may be carried by two persons so locking their arms together that a chair is improvised. If the distance is great, an ambulance may be devised by placing one or more mattresses in some covered vehicle of sufficient size. In lifting an injured person, three attendants are generally required: two to support the body, while one attends to the injured part. When about to convey by a stretcher, depute some one to keep back the crowd, while another goes before to secure a comfortable shelter. It is often advisable to cover the face of the injured one with a handkerchief, veil, or other light article, to prevent the uncomfortable feeling of being stared at. He should be instructed not to answer the questions of mere curiosity seekers.

SPECIAL DIRECTIONS.

Suffocation, Drowning, etc. — *Artificial Respiration.* There is a group of accidents in which death results from the deprivation of air. The poisonous carbonic acid gas, which ought to escape from the lungs during the process of breathing, and be replaced by the oxygen of the air, accumulates in the blood, deadens the activity of the nerve centres of the brain, breathing ceases, and, later on, the heart ceases to beat. The group comprises cases of suffocation, *i.e.*, smothering, hanging, choking, and drowning. Where there is insensibility or apparent death, resort must be had to *artificial respiration*, the practice of which may be readily understood by the following rules.[1] At the same time this process is being carried out, warmth may be imparted to the body by friction, and in cases of drowning, by substituting dry clothing or warm blankets for wet garments.

[1] In accidents of this kind the face is generally swollen and of a bluish color. Sometimes the eyes and tongue protrude. About the mouth is more or less mucus, occasionally streaked with blood.

Rule I. *Establish and maintain a free entrance for air into the windpipe.* The first part of this direction is complied with by removing tight clothing or other impediment from the face, neck, and chest, and by emptying the mouth, throat, and air passages. This latter process is accomplished by having the body placed for a few seconds on an inclined plane, with the head and face downwards. The operator, then opening the mouth, draws the tongue forwards, holding it by means of a handkerchief, and with the index finger of the other hand, covered with a handkerchief, sweeps around the mouth and throat, dislodging water, mucus, or other substance which may prevent the ingress of air.[1] The inclined position of the body favors the escape of any water that may be in the lungs or stomach.

The second part of the above direction is accomplished by *keeping* the tongue from falling back into the mouth until breathing is fully established, letting an assistant hold it with its tip on a level with, or a little beyond, the front teeth, or by fastening it there with an elastic band under the chin.

Rule II. *Place the body in the most favorable position for the full expansion of the chest.* This is in general upon the back, with the head and body inclined a little higher than the feet, and with a coat or two, shawls, a pile of sand or seaweed, under the back and between the shoulders, so as to throw out the ribs, and afford the greatest capacity to the chest.[2]

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[1] When accidents occur, medical assistance should be sought immediately, and, in cases of drowning, blankets and dry clothing sent for. Anything that impedes the breathing should be rapidly removed by cutting or tearing. Valuable time is lost by endeavoring to untie or unbutton. To hold a body up by the heels, so that the water (in cases of drowning) may run out, is unnecessary. To roll a body upon a barrel is a barbarous custom, is attended with the danger of injury to internal organs, and is not to be tolerated. It is seldom that any large quantity of water enters the lungs or stomach. Inclining the body upon a board or shutter, or by the aid of the hands alone is sufficient.

[2] This position is the one made use of in Sylvester's method of resuscitation. In the Michigan, and other methods to be hereafter mentioned, resuscitation is accomplished with the face downwards, or with the body lying horizontally

Rule III. *Imitate the natural movements of respiration, i.e.*, the chest is made to expand and contract slowly and methodically about *fifteen times a minute*, though at first the movements should not be more than four or five a minute. gradually increasing to fifteen. If suffocation is partial. as is sometimes the case in hanging, or smothering by irritating gases, or when the body has been immersed in water but a very short time, simple compression with the hands of the lower portions of the lateral chest walls, alternating with relief from pressure by removing the hands, associated with draughts of air and with dashes of cold water (or cold and hot alternately) upon the face, the tickling of the nostrils with a feather or the end of a handkerchief, or placing ammonia to the nostrils, tend to excite inspiration, and may be sufficient. If the case is a severe one, in addition to the above measures, one or other of the so-called methods of artificial respiration is to be used. The one most commonly used is "Sylvester's Method," viz.: the operator stands at the head of the patient. grasps both arms at or near the elbows, draws them steadily upwards until they meet above the head (thus air is drawn into the lungs by expansion of the chest), where they are kept for a moment, and then returned to the sides. Then gentle and firm pressure is exerted against the sides of the chest for a moment, aided, if possible, by pressure upon the breast bone, thus expelling foul air from the lungs. These movements are repeated alternately until breathing is restored, when attention is especially given to the establishment of circulation and warmth.

Rule IV. *Maintain the breathing now established by inducing circulation and warmth and by proper after-treatment.* Though the friction of the surface of the body by attendants, and the application of warm, dry blankets, may have been of some service, still, the warmth of the body must be promoted by

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on the side, or on the back, with the head lower than the trunk. The principal methods of resuscitation are given, that the operator may vary from one to another if he finds himself wearied by the pursuance of any one. The principles involved in all are essentially the same.

more friction under the blankets, and by the application of hot flannels, bottles or bladders of hot water, heated bricks, etc., to the pit of the stomach, the armpits, to the sides, between the thighs, and to the feet. If a house *is close by*, and the patient *can be carried to it safely*, if warmth is not fully established, a warm bath may be given, the body being immersed to the neck for not more than five or six minutes.[1]

As the patient is able to swallow, administer slowly sips of hot coffee, of wine, or warm brandy and water, or of one part of aromatic spirits of ammonia to five of water. Keep him quiet and warm in bed, in a well-ventilated room, and encourage sleep. Sometimes, even after he seems on the road to recovery, distressed breathing will occur from a secondary congestion of the weakened lungs, brought on by excitement or moving about too much. Large mustard plasters applied to the chest will help to relieve this condition. In conclusion, *all efforts to induce breathing and promote warmth and circulation in suffocated persons should be persisted in for at least one hour.* There are a number of recorded instances in which life has been restored after more than an hour's work.[2]

In "Marshall Hall's Method," the patient is placed face downwards, and gentle pressure exerted upon the back (to expel foul air from the lungs), then he is rolled over upon the side, or a little beyond, to draw air into the lungs.

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[1] Efforts at resuscitation should be begun wherever the patient is found. Lose no time in endeavoring to move him. After he does breath, carry him promptly to a house or under cover.

[2] How long a person may be immersed in water and be resuscitated is not definitely known, and depends on various circumstances. If water has passed into the throat, air is excluded, and suffocation is prompt. So also if the drowned person has been tossed about in the surf. On the other hand, if the drowning person is able to control respiration, and lift his head occasionally above the surface, life will be prolonged, and the chances for resuscitation are increased. Such also is the case if fainting occurs, as respiration and the heart's action cease through the action of the nervous system, and there are consequently no respiratory or circulatory efforts demanding air for the purification of the blood. It may be noted here that many persons, even good swimmers, are drowned by reason of being seized with cramps or spasmodic contractions of muscles which cannot be controlled. Persons who are subject to cramps or twitching of the muscles, or who are debilitated, should not venture into water beyond their depth.

These respective movements are alternately used, each occupying about four seconds, or used together, occurring fifteen times in a minute. The "Michigan Method" has the advantage that it can be used by *one* operator (the tongue of the patient not being held), and is of value if the person operated upon can be readily lifted by the operator. It is as follows:—

Instantly loosen or cut apart all neck and waist bands. Place the patient on his face. Bestride the body, with your face towards his head. Lock your fingers together under his abdomen, raise the body as high as you can without lifting the forehead off the ground, give it a smart jerk to dislodge water and mucus from throat and windpipe. Hold the body suspended long enough to count one, two, three, four, five, repeating the jerk more gently two or three times. Then, lower the body, and grasp the shoulders by the clothing or by your fingers in his armpits, and raise the chest as high as you can, without lifting the head quite off the ground, and hold it there long enough to count slowly one, two, three. Replace him on the ground with his forehead on his flexed arm, the neck straightened out, and the mouth and nose free. Place your elbows against your knees (on the inner side) and your hands upon the sides of his chest over the lower ribs, and press downward and inward with increasing force, long enough to count slowly one, two. Then suddenly let go; grasp the shoulders as before. Repeat the above movements alternately with regularity ten to fifteen times a minute for an hour at least, unless breathing is restored sooner. In restoring animal heat, warm the head nearly as fast as the body, lest convulsions come on. Before natural breathing is fully restored, do not let the patient lie on his back unless some person holds the tongue forward. The tongue, by falling back, may close the windpipe, and cause fatal choking.

"Satterthwaite's Method" is as follows: "In the first place, you must try and get something dry and warm to exchange for the wet clothing. Send at once for hot water, or have a fire built, into which bits of metal or stones may be thrown and heated, and by which you may warm blankets or the bystanders' clothes, which are to be applied in rapid succession.

"Next, try and get rid of the water by slightly elevating the body, while the mouth is wedged open and the tongue depressed. To do this effectively, roll the person on the face, raising the body, lower extremities, and feet slightly; then wedge open the mouth with a bit of wood, a knot in a handkerchief, etc. Then place the left forefinger on the back of the tongue and depress it. The finger will not be bitten, because the mouth is so wedged open that the teeth cannot close. This opens the windpipe better than if the tongue is merely drawn out. Then, getting beside or astride of the person, press with the flat of the hand upon the bowels, pushing them upwards at the same time. Very extreme pressure may be borne in this way, and the writer can say from personal experience that he has never seen any harm come from it. In half a minute, probably much less, the water will be driven out sufficiently to commence efforts at artificial respiration. Then turn the person over on the back, with the head still a little lower than the body, keeping, as before, the wedge in the mouth, the same finger on the tongue, and make upward pressure with the right hand upon the bowels. Press the right hand upwards and towards the spine until you hear the air passing out through the mouth. Commence

at first slowly, and, having driven out the air, remove the hand, that the air may again enter. Then make the upward pressure again, trying rather to exhaust the air thoroughly than to do it rapidly. At first, three or four motions in a minute will be sufficient; then gradually increase them from ten to fifteen a minute, and persevere at this rate until there are evidences of returning circulation, that is, pulse, or it is plain that life is extinct."

"Dr. Howard's Direct Method" is as follows: "Unless in danger of freezing, never move the patient from the spot where first rescued, nor allow bystanders to screen off the fresh air; but *instantly* wipe clean the mouth and nostrils, rip and remove all clothing to a little below the waist, *rapidly* rub dry the exposed part, and give two quick, smarting slaps on the stomach with the open hand. If this does not succeed, then turn him on his face, a large bundle of tightly-rolled clothing being placed beneath the stomach. Press heavily upon the spine, over the region of the stomach, for half a minute, then turn the patient quickly on his back, placing the roll of clothing under the back, so that the short ribs bulge prominently forward and are raised a little higher than the level of the mouth. Have the tip of the tongue held out of a corner of the mouth by a handkerchief in the hand of a bystander, and the arms stretched forcibly back above the head. Then kneel astride or beside the patient's hips, with your hands resting on the stomach; spread out the fingers so that you can grasp the waist about the short ribs. Throw all your weight steadily forward upon your hands, squeezing the ribs at the same time as if you wished to force everything in the chest upward out of the mouth. Continue this movement while you slowly count one, two, three, then suddenly let go with a final push, which springs you back to your first kneeling position. Remain erect upon your knees while you count one, two, then throw your weight upward as before. Repeat these entire motions with regularity; at first, about four or five times a minute, gradually increasing the rate to about fifteen times a minute. Continue the treatment for at least two hours, if not successful before, meanwhile applying friction to the limbs; and even after he has begun to breathe assist him by well-timed pressure to deepen his first gasps into full deep breaths."

Intoxication. — *Symptoms:* Breath has the odor of liquor,[1] insensibility more or less complete, usually can be roused, breathing quiet, pulse frequent, pupils slowly respond to light. *Treatment:* Emetics,[2] cold douches, slapping of the face or other sensitive parts of the body.

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[1] It has often happened that a perfectly temperate person, feeling faint or exhausted, has taken some alcoholic stimulant, which, being perceptible in the breath, has, upon the supervention of a serious accident, led the bystanders to conclude that he was intoxicated. We should always be on our guard against such a mistake, for it not only causes an utter neglect of such measures as are necessary to recovery, but leads to great injustice and mortification.

[2] For emetics, see p. 343.

Apoplexy. — *Symptoms:* Patient generally insensible, face flushed or very pale, pulse full, pupils *do not* respond to the light, breathing is more or less noisy, paralysis of face or one or more of the limbs, sometimes convulsions. *Treatment:* Rest in recumbent position, loosen the clothing about the head, neck, and chest. If head hot, apply cold. *Keep patient quiet.* Other means leave to the doctor.

Convulsions or Fits. — Do not attempt to hold the patient still. Merely prevent him from injuring himself. If there is danger of the tongue being bitten, place a piece of wood (head of a clothes-pin, for example) between the teeth. In the ordinary convulsions of children, from undigested food, etc., and in convulsions from blood poison, place the patient for a few moments in a warm bath. If the head is hot, keep cool water applied to it during and after the bath. In the convulsions of epilepsy, baths are not to be used; quiet is the chief requirement.

Fainting Fits (syncope). — Danger at times from feeble heart. Remove patient instantly from a crowd; place in a recumbent posture. Life may be lost by keeping a fainting person in an erect posture.

Sunstroke and Heat Exhaustion are two conditions entirely different, but caused by fatigue and prolonged exposure to great heat either by day or night. They are most likely to occur in feeble and intemperate persons, among those who work under the direct rays of the sun, or in badly-ventilated and overheated kitchens, laundries, and workshops, or who wear in hot weather too much clothing, especially heavy head-coverings, and who drink to excess of iced drinks.

In sunstroke, the skin is hot, pulse full, and breathing labored, and the patient may be unconscious. There is danger from the congestion which occurs in the internal organs. *Treatment:* Recumbent posture in a cool place, ice to the head, and cold douches upon the face, neck, chest, and spine, at-

tended with friction until consciousness returns. Stimulants are indicated if the pulse is very weak, and if reaction does not soon set in, mustard (but not to blister) may be applied to the feet and back of the neck and to the chest. When there is apparently no active congestion, but evidences of heat exhaustion, stimulants are to be used from the first, and cold applications sparingly, if at all. It may be necessary to induce warmth.

Burns and Scalds.—Burns are caused by the contact of the body with fire, heated substances, or chemical agents. Scalds, by the contact with steam or boiling liquids. The danger in either case is from shock, and from inflammation of internal organs, and is increased generally in proportion to the nearness to the vital organs, the amount of surface injured, and the destruction of the sub-lying tissues. Cases are on record of lockjaw and other serious troubles following what are considered slight burns. If you see a person on fire, act promptly. Pick up the nearest rug, shawl, table-cover, overcoat, or slip of carpet, or, if necessary, tear down a curtain. Hold it before yourself to protect you as you proceed to wrap it around the burning part, keeping the flames as much as possible from the face of the sufferer, so as to prevent the entrance of overheated air into the lungs. If necessary (without parleying), throw the burning person to the ground and roll him over and over in the blankets, carpets, or other woollen material, at the same time that an assistant drenches with water the cinders and half-burnt clothing.[1]

Treatment of Burns and Scalds: 1. Remove, by cutting with scissors, all the clothing you can about the injured parts, being careful not to tear blisters open. Soften by water all adherent pieces of clothing. Cover the burned or scalded places with strips of soft linen or cotton cloth (not with cotton bat-

[1] Kindling fires with kerosene oil, filling lamps when they are lighted, letting lighted lamps fall, running or moving quickly while one's clothes are on fire, working about open fires in loose cotton dresses, are all sources of danger.

ting, for it adheres too closely, and is too heating) saturated in a mixture of carbolic acid or creosote with glycerine and olive oil, one teaspoonful of the first or the second ingredient mixed with the same amount of glycerine, and then well shaken together with one pint of oil,[1] or saturated in carbolized vaseline, or in a mixture of equal parts of oil and lime-water, or a strong solution of bi-carbonate of soda. Or, the spots may be covered with chalk, soap, cream, or any substance that will exclude the air. When blisters form, their contents may be removed by slight punctures of a sharp needle. 2. In severe cases, there is more or less shock, and it may be necessary to suspend local measures, and revive the patient by stimulants, as before directed in cases of shock. 3. Do not remove the dressings unless cleanliness demands it. When you do, use great gentleness, that you may not injure newly-formed skin. Oily dressings should, from time to time, have fresh oil applied over them, and it is well to spray liquid dressings with a mixture of carbolic acid, one teaspoonful to eight ounces of water. 4. Troublesome, contracting scars sometimes follow burns, producing deformities. Especially is this the case at the bend of a joint, or where the skin is loose, as about the eyes, mouth, and neck. In short, there is great responsibility involved in the care of burns and scalds, and no person should attempt their continued treatment unless he is thoroughly versed in antiseptic surgery.

Frost Bite. — This results from exposure to severe cold. The vitality of the part is reduced to a low point, and becomes bluish or white. Sometimes exposure to cold winds gradually produces a congestion of internal organs, and a tendency to sleep; and, if the person indulges in it, in the open air especially, death may result.[2] To bring about reaction, place the

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[1] This mixture is much cleaner than many of the burn mixtures, and quiets pain. It should be kept on hand in houses and factories. In case olive oil cannot be obtained, other oils will answer. Strips of cloth are to be preferred to large pieces, as they can be more readily removed.

[2] If caught in a snow-storm, do not suffer yourself to be overcome with sleep until you have found a spot of some sort sheltered from the wind.

person in a room without fire, and gradually rub the chilled or frozen parts with ice, snow, or cold water. Stimulants may be necessary. When the parts begin to redden and sting, or become painful, reaction has commenced and care is necessary (by rest, sleep, and *gradually* increasing warmth) lest the returning circulation in the skin become too active, so as to cause inflammation.

Fractures and Dislocations. — The signs of a fractured or broken bone are generally more or less change in the shape and natural appearance of the injured part, pain and inability to move the part readily, tenderness and unnatural mobility at the point of injury, and a grating sonnd when the fragments of bone are gently rubbed against each other. The symptoms of dislocation, or "bones out of joint," are in general the opposite to those of a fracture. There is ordinarily marked deformity and impaired motion. *Treatment:* There is generally but little urgency in the treatment of a broken limb. The common impression that a broken bone must be immediately set is erroneous, and tends to induce much handling of the injured parts, which is always dangerous, as jagged ends of bones may be made to injure the soft tissues. Put the patient in as comfortable position as possible, pending the arrival of the surgeon. Support the affected part by pillows, blankets, shawls, or coats, so as to prevent the painful twitchings of the injured muscles, and to preserve, as nearly as possible, the natural shape of the part. In case of fracture of the collar bone, place the forearm gently in a sling, improvised from a long towel, or a shawl, or a piece of cloth, with a soft pad in the armpit of the affected side, and let the patient lie on his back, with a small pillow between the shoulders. In case of removal of the patient, steady the afflicted arm by a bandage over it and around the body. A broken arm is made most comfortable by placing it in a semi-flexed position upon a pillow; a broken leg, by gently extending it to its full length and supporting it by pads on both sides. With a broken knee cap, the leg should be elevated on an inclined plane, with a figure-of-8 bandage about the

knee. If one or more of the ribs are broken, apply a bandage firmly around the chest to prevent motion as far as possible. When a jaw bone is broken, hold the parts in proper place by a bandage about the head. When the patient is to be removed, more support to the fragments is necessary, by the binding on of "splints," that is, softly-padded shingles, pieces of leather, sticks, or anything that can serve to hold these fragments quiet and, nearly as possible, in line.

The setting of a bone should be accomplished by a surgeon. When once the fragments are adjusted, they should not be disturbed.[1]

In a case of dislocation, it is incumbent upon the bystanders merely to make the sufferer comfortable, and to convey him carefully to a place where a surgeon can be obtained. The reduction of a dislocation is oftentimes more difficult than the setting of a bone, and it should never be attempted by a layman if a surgeon can be obtained.

Sprains are bruised or torn ligaments, cartilages, muscles, and nerves about the joints, and are serious injuries. After such an injury, though apparently slight, *rest is necessary*, and this may be temporarily obtained by firmly, but gently, wrapping the part in cloths or bandages dipped in hot or cold water, as the feelings of the person may indicate and the surroundings admit of. The surgeon may ultimately apply a proper splint.[2]

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[1] The process of repair in broken bones is similar to that witnessed in the healing of wounds of the soft parts. New, delicate material is abundantly deposited between and about the ends of the broken pieces. This gradually hardens to the consistency of bone, in the meantime decreasing in size, so that, if the fragments have been kept well in place, very little deformity results. The best surgeons are at times unable to prevent deformities, owing to their inability in certain instances to secure the proper apposition and retention of the broken parts. An unprofessional person should not attempt to set a broken bone if a surgeon can possibly be procured. Movements of the body or limbs, though carefully made, may cause the sharp edges of bone to cut into important structures, blood-vessels, nerves, etc. Fatal injuries may, in this way, result.

[2] So serious oftentimes is the injury to the ligaments, muscles, and other tissues about a joint, that sprains have been spoken of as "broken joints."

Contusions or Bruises result from falls, blows, or pressure, and, if severe, are attended by shock, broken blood-vessels, and crushed muscles and other tissues. The black and blue spots, which result from the oozing of blood from the blood-vessels, and which disappear after a few hours or days, are generally the largest where the tissues are the loosest, such as the connective tissue under the skin of the scalp and eyelids. The treatment of contusions is rest, relief from shock, the elevation of the bruised part, so as to retard the flow of blood into it, and the application of cold by water or powdered ice in towels or rubber bags.[1] The wet towels must not be kept on long enough to act by their warmth as poultices, or to soak the individual's clothing.

Wounds are generally classified as follows: —

INCISED WOUNDS, *i.e.*, cuts or incisions of various depths, made generally by sharp instruments, such as knives.

PUNCTURED WOUNDS, such as stabs, and pricks made by splinters, thorns, needles, etc.

POISONED WOUNDS, from the bites of snakes, spiders, rabid dogs, etc. If the wounded part is very much bruised, the wound is called a *contused wound*. If the skin and tissues beneath are much torn, it is a *lacerated wound*.

All wounds are attended by more or less hemorrhage, by pain, and by the presence of dead or foreign matter, viz., fibres of cloth, dirt, and coagulated blood.

Treatment: Ascertain the source and amount of the bleeding, and do not be alarmed by the *amount of the clothing stained*, for a small amount of blood will oftentimes make a large stain, and yet the source of the bleeding may frequently be controlled with ease.[2] When the wound is located, the kind of hemor-

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[1] Sixty drops of tincture of arnica, or extract of witch-hazel, may be added to half a pint of water. Water dressings, if continued too long, lower the vitality of the part.

[2] A surgeon relates the following: "Was called one night to see a woman reported to be bleeding to death. Found her in a close room, sitting in a chair, with blood-stained carpet about her, and, wrapped around one of her legs, a sheet soaked in blood. Tearing this off, I found a little stream of blood trickling

rhage will be apparent. If a large artery has been cut across, the blood spirts. The wound being found, if the blood has ceased to flow, from the spontaneous coagulation of blood, it may be wise not to disturb the condition of things, if there has been much shock, until removal to a better location; but remember that in the removal, if the person is jarred much, bleeding may recur, and will need to be checked. To stop external bleeding, *pressure is of the first importance*, then applications of ice, cold water, tannin, or alum. If the bleeding is comparatively slight, or occurs in places where the bones beneath are near the surface, as in the scalp and face, pressure may be applied to the wound by the fingers, or by a pad held firmly in place by a bandage. If severe, and especially if arterial in character, *i.e.*, coming in jets of a bright red color, pressure must be made between the wound and heart, a pad being bound over the main artery; or, in the case of a limb, it should be elevated, and the artery should be pressed upon by a knot in a handkerchief, towel, suspender, or piece of cloth, tied about the limb, the knot over the blood-vessel, and then twisted by means of a stick until the bleeding ceases.[1] When this is controlled, the wound should be quickly washed with cold water, and the foreign matter carefully removed, and any organs which have protruded replaced. Then dry it gently, and, if the wound is an incised one, bring its edges together by strips of surgeons' adhesive plaster, parallel to each other, and from one-half to one-fourth of an inch apart, by rubber plaster, or by the thin isinglass plaster, if it can be kept dry. Never cover the entire wound with plaster, as some exit must be allowed for any oozing that may occur.

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from a small opening in a broken vein between the knee and the ankle. Pressure with the finger readily controlled the bleeding for the time, and a properly applied bandage accomplished the end afterwards. Much anxiety, loss of blood, and injury to carpet, might have been saved by a little coolness and knowledge."

[1] The main artery of the arm runs along the inner edge of the prominent muscle, which stands out when the arm is strongly bent; of the thigh, along its inner middle line. These arteries, and other principal ones, are outlined in Fig. 47.

The tourniquet may now be removed, if the proceeding be not attended with renewed bleeding, and a graduated pad and bandage applied, to assist in keeping the strips in position and to prevent secondary bleeding.

If the wound is jagged and torn, the edges cannot be brought together. Replace the parts as near as possible in their normal position, and, if there is a tendency to bleeding, apply cloths wet with cold water. If there is no such tendency, hot applications (poultices and water dressings) may be applied at the outset.

Punctured Wounds, on account of the bruising which generally accompanies them, the injury to the deeper tissues, and sometimes the character of the sources of injury, — rusty nails, pieces of shell, needles, splinters of wood, etc., — are generally considered the most dangerous, and if in the sole of the foot, or palm of the hand, may give rise to lockjaw, and are frequently followed by erysipelas and other forms of inflammation; whereas, the principal danger from an incised wound is hemorrhage.

Treatment: If the sources of the injury are still in the wound, remove them. Thorns, needles, splinters, etc., should not be left in the body under the idea that they "will work their way out." Poking at them, however, as in the case of splinters, adds to the irritation already set up. If a splinter is under the finger or toe nail, and cannot be pulled out, scrape the nail thin over the splinter until it can be easily cut and the splinter seized, or make an incision on each side of the foreign body and remove the tongue of nail between. The skin and tissues of the palm and the sole are so firm and dense that imprisoned matters cannot easily find exit, and lockjaw is liable to result. It is important, therefore, that an incision should be made over the foreign substances, so as to reach it easily and allow a free exit for blood, etc. The removal of needles had better not be attempted by others than surgeons, unless they are near the surface, as they readily slip, on being touched, between the fibres of muscles and connective tissues. If there is a tendency to such slipping, or the needle seems deeply buried, hold the part still till the surgeon comes.

When a fish-hook enters a part, and does not go through, push the point through if possible, and then cut the barb off and withdraw the remnant. If it cannot be pushed through, it is best to cut down upon it and so remove it. In these wounds, carbolized water dressings, one drachm (*i.e.*, about a teaspoonful) to ten ounces of water, are best. Pain may be relieved by the addition of laudanum, one-half ounce (*i.e.*, about one tablespoonful) to pint of water.

Poisoned Wounds, which remain for consideration, will be treated of under the head of poisons.

Special Hemorrhages. — Of these, the most common and the least dangerous is bleeding from the nose. It results from falls, blows, or disease, or it is an effort of nature to relieve some internal congestion, and is often preceded by a feeling of weight, pain, and fulness about the forehead. *Treatment:* Ascertain if the blood escapes from one or both nostrils, then raise the arm of the affected side above the head, compress the nostrils, and apply cold to the forehead or back of the neck. Frequently it is sufficient if one remains quietly in a sitting posture. If the bleeding continues, and the person is faint, inject into the affected nostril a syringeful of ice-water or solution of common salt (*i.e.*, one teaspoonful to large wineglass of water), or a dilute solution of alum, or blow in some tannin. The nostrils may be plugged by cotton dipped in one of the above solutions. If blood still forces itself into the throat, and so out of the mouth, a surgeon must be seen. In all forms of hemorrhage, the patient must be kept in a cool room and quiet, and when faint from severe bleeding, in a recumbent posture, with the head lower than the body. Bleeding from the mouth is generally relieved by pressure and by one of the above styptics. Bleeding from the stomach is generally attended by dark blood mingled with food. From the lungs, the blood is bright red and frothy, mixed with bubbles of air, and is generally accompanied with a cough. For relief, quiet and recumbent posture, ice and styptics internally in small quantities, so as not to induce vomiting; cold may be applied over the

region of the stomach. Bleeding from the gum, after the extraction of a tooth, is sometimes alarming, but continued pressure in the socket with the tip of the finger, or a piece of sponge, or a plug of wood supported by the jaws, which are held together by a tight bandage about the head, is ordinarily sufficient. When pressure, cold, and ordinary styptics, will not control hemorrhage, touching the bleeding spot with a red-hot knitting-needle is of service.

Foreign Bodies. — Pieces of chicken-bone or fish-bone, meat, or other food, pins, false teeth, etc., sometimes lodge in the larynx, causing great difficulty in swallowing and breathing, and give rise to the feeling and danger of suffocation. *Treatment:* A sharp blow upon the back, if given immediately after the accident has occurred, will sometimes assist the patient to eject the foreign body. If it fails, invert the patient, and move him from side to side, while some one strikes the person between the shoulders with the open hand. If this fails, and the foreign body cannot be dislodged by the finger introduced into the mouth, or by long, curved forceps, the surgeon is needed.

Little children in play sometimes put peas, beans, shoe-buttons, pins, etc., into the nose or ears. Insects also enter these places. Foreign bodies in the ear, if not removed, may create inflammation, which may extend through the drum membrane to the brain. Small bodies may be removed by syringing with tepid water, the nozzle of the syringe being placed against the upper wall of the ear canal. Larger bodies may be gently scooped out by a bent probe, or the rounded end of a hair-pin, care being taken not to injure the drum membrane. Insects may be washed out after being smothered with salt water, oil, or by the vapor of vinegar from a saturated piece of cotton wool placed in the external opening. If the foreign body is up the nostril, close the unaffected nostril, take a full breath through the mouth, and then breathe out suddenly and forcibly through the affected nostril. Sometimes snuff will

cause enough sneezing to dislodge it. If the breathing in is *too forcible*, the body may be carried high up.

Foreign bodies in the eye, such as sand, broken eyelashes, cinders, and pieces of metal, if not removed promptly, cause serious inflammation. Never rub the eye to dislodge particles. If on the front of the eyeball, gently remove with a piece of wet cotton wrapped around a very small, smooth piece of wood, or with a moist camel's-hair brush; or, if it is a metallic substance, use a magnet. Sometimes it is difficult to see a minute particle unless a bright light falls directly upon the eye. The best position for the operator is to stand behind the chair of the patient, or a little to one side, steady the affected eye, and keep the lids open with the fingers of the left hand. A magnifying glass is of service in detecting whether a supposed particle is one in reality or merely a stain from a piece of metal or a natural discoloration. Eyestones are sometimes used to dislodge particles from under the eyelids, but it is much better for the patient to take hold of the lashes of the upper lid, raise it from the eyeball, and then move it forcibly over the lower lid towards the inner corner of the eye; or, the assistant, sitting in front of the patient, turns the upper lid gently backwards, and over a lead-pencil, penholder, or firm tooth-pick. The lower lid can, in general, be readily everted. The inflamed condition of the eye, left after a foreign body has been in or upon it, is generally relieved by a drop of olive oil or castor oil upon the eye, or by a gentle sopping with warm water, or with borax and camphor water (ten grains to the ounce), putting a teaspoonful of this mixture in a tablespoonful of warm water. Poultices or patented eye-washes should not be used. In case lime has got into the eye, bathe the eye with a weak solution of vinegar and water.

POISONS.

A poison may be defined to be "any substance which, when introduced into the system, or applied externally injures health, or destroys life irrespective of mechanical means, or

direct thermal changes."[1] Its action is: 1. *Local*, producing pain and soreness in the mouth, stomach, lungs, or bowels, associated it may be with vomiting, and difficult breathing and swallowing, due to injury to the throat and windpipe; or the poison may eat or destroy the tissues with which it comes in contact, but does not as a rule suspend consciousness. 2. The poison may act *remotely*, *i.e.*, through the blood and nervous system, and produce delirium, excitement, convulsions, stupor, or marked prostration. 3. It may act both locally and remotely. Those poisons whose action is chiefly local are the *irritant*, and the *acrid*, *escharotic*, or *corrosive poisons.* The first group includes some of the metallic poisons, such as copper and mercury, and some irritating gases, and also certain vegetable, animal, and mineral substances, such as tansy, poke-berries, cantharides, decayed meat, and poisonous fish. The second group comprises the strong *acids*, such as sulphuric, nitric, muriatic, and oxalic; alkalies, such as potash and ammonia, acid and alkaline salts, corrosive sublimate, etc.

Those poisons which act "remotely" are termed *narcotic* or *neurotic* poisons, and include such substances as opium, chloral hydrate, alcohol, belladonna, aconite, etc. Those poisons which produce *both local and remote effects* are the acro-narcotic poisons, pink-root, ergot, lobelia, etc., and the septic poisons in venomous bites and stings and virulent wounds. Usually we suspect poisoning if a person is taken *suddenly and violently ill*, especially if there is great pain and repeated or severe retching or vomiting, and it is known that food or drink has

[1] The above definition, from Quain's *Dictionary of Medicine*, seems to be the best. There is no legal definition of a poison. A popular idea is that a poison is a substance which, taken in small amount, will destroy life. The fact is, there are varying degrees of susceptibility to the action of a poisonous substance, and by the habitual use of a substance large doses may often be taken with impunity. There are some persons, on the contrary, who are so susceptible that they cannot take, for example, even the most minute dose of calomel without a resulting sore mouth, or of belladonna, without its producing a dry throat and dilated pupils. Of the lower animals, hogs, it is said, can eat henbane with impunity; pheasants, stramonium; goats, tobacco and water hemlock.

been recently taken.[1] It sometimes happens that severe colic from undigested food, an attack of cholera morbus, the pain and distress referable to heart disease, the stupor due to an apoplexy, are mistaken by the ignorant for the symptoms of poisoning, and the patient is roughly and wrongly dealt with. To ascertain, carefully examine the mouth, lips, and breath; search the clothing and the room in which the poison is supposed to be.[2] A person who has taken poison with intent to kill is likely to prevaricate and destroy the evidence of the poison used.

Spasms, with more or less unconsciousness, will lead you to suspect strychnine; quiet, deep sleep, from which a person is not readily aroused, and strongly contracted pupils, indicate opium; stupor, with salivation, — mercury; inflammation of the mouth, severe pain, retching, and vomiting, — arsenic or other corrosive poison; delirium, — belladonna, stramonium, or hyoscyamus; unusual excitement, with occasional stupor, — alcohol and Indian hemp; loss of muscular power, feeble pulse, great prostration, paleness and coldness of the skin, — tobacco, aco-

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[1] Poison may slowly do its work if taken in small amount and repeatedly, and the person be considered sick with a chronic disease. Such poisons are called *cumulative*. Lead and arsenic are examples.

[2] Stimulants and medicines containing poisonous ingredients, as chloroform, opium, belladonna, fusel oil, etc., should not be left within the reach of little children or others likely to use them recklessly or without cause. Such things should be in bottles of a peculiar shape, and with peculiar colored labels.

"At a recent convention of pharmacists in England, the importance of fixing some legal limits to the wholesale poisoning of the public by patent medicines was urged. It was proposed that even if it were impossible altogether to suppress the imposition of dishonest quackery upon vulgar superstition, the venders of nostrums should at least be compelled to divulge the composition of their wares, and prevented from publishing mischievous and mendacious advertisements concerning them. Among the examples cited were included sundry 'hair restorers,' which, in direct contradiction to their advertised pretensions, contained poisonous quantities of lead. But the most glaring imposition was a largely certificated 'Sure Cure for the Opium Habit,' which was found on analysis to give two grains of morphine to the dose, and was recommended to be taken thrice a day. . . . It would be well if the American public were taught that ninety-nine hundredths of the proprietary medicines which flood the market are the products of uneducated imposters, and are either wholly inert or positively deleterious." — Dr. A. N. Bell.

nite, or digitalis; bloated and livid face, limbs contracted, head thrown back, — the suffocative gases.[1]

Treatment: Whatever the poison may be, the indications for treatment are: 1. To get the poison out of the body by encouraging vomiting. 2. To neutralize, or render inert, by means of antidotes, what cannot be removed. These act mechanically, chemically, and by reason of their physiological properties. 3. To combat any dangerous symptoms that have arisen, and to obviate their effects by means of stimulants, artificial respiration, and exciting the action of the skin, kidneys, and bowels. To remove the poison as quickly as possible from the body, resort is had to emetics, to produce vomiting. Give at least every *fifteen minutes*, until the effect is produced, copious draughts of warm (tepid) water or other drinks, or one pint of warm water with half an ounce of mustard,[2] well stirred in together, with half an ounce of common salt, or two teaspoonfuls of powdered alum with an ounce of syrup, or one or two tablespoonfuls of wine of ipecac. Tickling the throat with a feather assists the act of vomiting. If the person will not swallow readily, close the nostrils with the thumb and finger while the emetic is given. Insert, if necessary, the thumbs behind the teeth and between the jaws, and so pry open the mouth and depress the tongue with the handle of a strong spoon, a clothespin, or stick. By pressing on the jaws at their joints, the mouth will be forced open.

Second, *To neutralize or render inert what cannot be removed.* Examples of chemical neutralizing substances are weak acids (lemon juice or diluted vinegar), to be used when the poisons are such alkalies as lime potash, etc.; or, on the other hand, alkalies such as lime-water, weak soda-water, and soap-suds to neutralize acid poisoning. Common salt with milk and the

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[1] Alcoholic stimulants may hide the common symptoms of poisoning. The profound sleep of some intoxicated persons resembles closely the sleep produced by opium.

[2] The mustard should be thoroughly mixed with the water lest some of it may cling to the lining of the stomach and excite inflammation. The stomach pump should be used by physicians only.

white of the egg should be opposed to nitrate of silver, verdigris, and corrosive sublimate. The fresh hydrated sesqui-oxide of iron, formed by precipitating tincture of chloride of iron with an excess of ammonia, is an antidote for arsenic and metallic poisons generally. Belladonna is an example of a physiological antidote. It dilates the pupil of the eye, in opposition to opium, which contracts it. Coffee is a valuable physiological antidote to opium, its tendency being to excite and to overcome stupefaction. Mechanical antidotes, *i.e.*, such as allay irritation, are olive oil, milk, flour and water (in a thin paste), chalk mixtures, castor oil, mucilage, flaxseed tea, the white of egg and water, etc.; and, in case of strychnine poisoning, charcoal mingled with water. They serve to coat over the irritated mucous membrane, and thus protect it.

INDIVIDUAL POISONS.

IRRITANT AND CORROSIVE POISONS.

If the poison taken is *known* to be a corrosive one, emetics should be omitted, and recourse had immediately to antidotes.

1. ***Acids***. — Sulphuric (oil of vitriol), nitric (aqua fortis), chlorohydric or muriatic, oxalic, carbolic,[1] acetic, etc. The first three of the above are much used in certain factories, photographing establishments, etc., and are sometimes left carelessly about. Oxalic acid resembles in appearance epsom salts, and is sometimes taken by mistake for the latter. It is frequently used to polish kitchen boilers.

Antidotes. Baking soda, chalk, magnesia, wall plaster or saleratus mixed with water, lime-water, soap-suds, oil in large amount, followed by mucilaginous drinks, stimulants. When sulphuric acid has been taken, it should be quickly diluted by a free use of ice water.

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[1] Carbolic acid, so called, is not properly an acid.

2. ***Alkalies and their Salts.***— Ammonia (hartshorn, liquor or water of ammonia, muriate of ammonia or sal ammoniac), potassa (caustic potash in sticks and crystals, mistaken by a child for candy; ley; liquor potassae, a clear, liquid medicine; pearlash or carbonate of potash; nitrate of potash, or saltpetre, used in corning beef, etc., has been mistaken for purgative salts; chlorate of potash, a common remedy for sore throat, has been used unwittingly in large and poisonous doses; binoxalate of potash, has been taken by mistake for cream of tartar), soda.

Antidotes: Vegetable acids, such as vinegar, lemon juice, citric and tartaric acid in solution; fixed oils, viz., castor, linseed, olive, cod-liver, machine, form soaps and so prevent caustic effects; mucilaginous drinks, especially when saltpetre has been taken.

3. ***Metallic Substances.***— ANTIMONY: in the medicines, tartar emetic and wine of antimony, an ingredient of pewter, of Britannia, and type metal; oxide of antimony.

Antidotes: Assist the distressing vomiting by draughts of tepid water, flaxseed tea, sugar water; give teaspoonful of tannin; a cup of strong, green tea.

ARSENIC: an ingredient of paris green, used as a paint, and to destroy insects among plants; of orpiment, a yellow paint; of realgar, a red paint; of arsenite of copper, or scheeles, green; in some brightly colored artificial flowers, wall papers, candy boxes, and kindergarten papers; in fly powders, rat pastes; used in the stuffing of birds, by enamellers, and in fowlers' solution; a medicine. Arsenic, as ordinarily obtained in the shops, is a fine, white powder, and may be mistaken for sugar or some equally harmless substance.

Antidotes: Freshly prepared peroxide of iron (to be obtained at a drug store) in large quantity, or mix three or four tablespoonfuls of aqua ammonia with one or two tablespoonfuls of muriated tincture of iron, strain through a cloth, and use the brownish precipitate left on the cloth after washing with water. Give one teaspoonful every few minutes. Dialysed iron, char-

coal, and calcined magnesia are other antidotes. Encourage vomiting. Allay irritation.

Copper: in some cooking utensils; in the alloys, bronze, brass, bell metal, german silver, etc.; in sulphate of copper or blue vitriol, acetate of copper or verdigris. Poisoning has occurred from pickles made green by copper; by the use of colored confectionery; from the wrappers of farinaceous foods; inferior gold filling for the teeth, and copper dust in some of the trades.

Antidotes: Milk; white of eggs; enough baking soda to cover an ordinary nickel cent, every five minutes for half an hour. Allay irritation.

Lead: In the acetate or sugar of lead often used as an application to sores, or as an eye wash;[1] in "white lead" and "red oxide" of the painters; in some hair dyes; water kept in leaden vessels or pipes; wines sweetened by lead; tin foil covering of tobacco and farinaceous foods; pickle jars with metal tops, and in newly painted rooms. Poisoning by it has occurred among the makers and users of glazed cards, japan ware, cosmetics, lead type, and tin spoons.

Antidotes: Strong solution of Epsom or Glaubers salts, for the soluble preparations of lead; dilute sulphuric acid for the insoluble.

Mercury: Bi-chloride or corrosive sublimate, used in solution as a medicine, as an ingredient of freckle and other lotions, and for the destruction of vermin; an ingredient of the red oxide or red precipitate, white precipitate, etc., upon looking-glasses. Used in the preservation of stuffed birds and animals, etc.; is corrosive.

Antidotes: White of eggs; flour beaten up with milk and water.

Silver: Lunar caustic or nitrate of silver, an ingredient of hair dyes; used in solution as a lotion; some forms used in photography and the trades.

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[1] Eye-washes containing lead are apt to cause opacity of the eye.

Antidotes: One to two teaspoonfuls of salt in a tumbler of water decomposes the poison and arrests its activity. Allay irritation.

ZINC: Sulphate of zinc or white vitriol, used in lotions; chloride of zinc in disinfectants.

Antidotes: Carbonate of soda in water; milk and white of eggs. Vomiting relieved by copious draughts of warm water.

TIN: In some dyeing substances; in poor cans for the preservation of food.

Antidotes. See COPPER.

IODINE: Ordinary tincture of iodine, as in some liniments.

Antidote: Starch and water.

IRON: Copperas, green vitriol, or sulphate of iron, used in lotions and as disinfectant.

Antidotes: Baking soda and mucilaginous drinks.

PHOSPHORUS: An ingredient of many rat poisons. Children have been poisoned by eating these, and by sucking matches. The vapor in match factories is a source of poison.

Antidotes: Large quantities of magnesia or chalk in water; milk of magnesia; white of eggs. *Avoid fatty substances.*

4. ***Gases.*** — CHLORINE: A suffocative gas used in trades and chemical experiments. CARBONIC OXIDE (generally odor of stove gas): From incomplete combustion in stoves and furnaces. CARBONIC ACID (choke damp): In deep wells, cisterns, and vats in closed cellars; in mines, sewers, etc. SULPHURETTED HYDROGEN (odor of decaying eggs): Subtle poison, found wherever there is putrefaction; in cesspools, sewers, outhouses, etc. ILLUMINATING GAS, etc.

Antidotes: Fresh, pure air; dashes of cold water upon the face; inhalation of vapor of ammonia; artificial respiration.

5. ***Animal and Vegetable.*** — POISONOUS FISH: conger eel, bladder fish, gray snapper, etc., with some; some shell-fish.

Antidotes: Emetics; emollients; strong purgative; stimulants.

Oil of Savin: Volatile oil from the red cedar, sometimes improperly used medicinally, is a marked irritant.

Antidotes: Ice; coffee; ten drops of paregoric every fifteen minutes till relief. Allay irritation.

Croton Oil: A violent purgative, also used in liniments; may be mistaken for a harmless oil. Poke Berries: sometimes eaten by children. Oil of Tansy; Beans of the Castor-Oil Plant, sometimes eaten by children. Common Wild Parsnip; Oleander; Marsh Marigold. Cantharides or Spanish Fly; Colchicum, used frequently in rheumatic medicines, etc.

Antidotes: After vomiting, strong coffee or vinegar and water; mucilaginous drinks; stimulants.

ACRO-NARCOTIC.

Lobelia or Indian Tobacco, used medicinally; Meadow Saffron; Spigelia or Pink Root, sometimes recklessly used as a vermifuge. Spurred Rye, or Ergot, in medicines, sometimes ground with the rye. Sanguinaria, or Blood-Root, in medicines. Nicotine of Tobacco, especially in pipes and cigar-holders long used; in cigarettes and chewing tobacco. Mushrooms (some varieties): The edible has purple spores; gills are at first delicate pink, afterwards purple and tawny black; stem white, full, firm, varying in shape, *with a white, persistent* ring.[1] It must be sought for in the open fields. The best kinds have an agreeable odor, and do not change color when plucked and exposed to the air. Poisonous mushrooms, according to Chrystisin, are recognized by their dark color; acrid, bitter taste; pungent odor; and by the fact that they generally grow in dark, damp places.[2] Aconite (Monkshood, Wolfsbane):

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[1] *Fungi and their Uses.* Cooke.

[2] "On the subject of distinguishing poisonous species, Mr. Cooke says that there is no golden rule which will enable us to tell at a glance the good species from the bad. The only safe guide lies in mastering, one by one, the specific distinctions, and increasing the knowledge through experience, as a child learns to distinguish a filbert from an acorn, or a leaf of sorrel from one of white clover. The characters of half a dozen good, esculent species, he says, may be learned as easily as the ploughboy learns to discriminate as many species of

Preparations of leaves and roots used medicinally, internally, and in liniments. Preparations of the root are several times stronger than those of the leaves. The plant has been mistaken for the horse radish. This poison produces peculiar numbness, or tingling sensations in the mouth, throat, and skin. MEZEREON: A garden shrub having bright red berries, sometimes eaten by mistake for currants.

Antidotes: Fresh air, stimulants, electricity, cold douches, artificial respiration Allay irritation.

THE SEPTIC POISONS.

Venomous Bites and Stings. — In case of snake bite, or that of a rabid animal, or one supposed to be mad, tie a string or handkerchief tightly about the limb just above the bite; then suck the wound, or encourage the blood to flow by means of a cupping-glass. Wash out the wound and rub thoroughly into it a piece of nitrate of silver, or paint it with tincture of iodine, or press into it, for a moment, the end of a red-hot knitting-needle or steel for sharpening knives. Sometimes the bite of a human being is very dangerous.

Treatment: In case of snake bites especially, administer alcoholic stimulants freely. To the wounds made by bites and stings, apply mild, unstimulating applications, viz., oil, vaseline, cold cream, suet, etc. Support the patient's strength. Stings of bees, wasps, scorpions, etc., extract the "stinger" by fingers, small forceps, or pressing about it with the barrel end of a watch key; then apply spirits of ammonia, saleratus water, or mud.

Virulent Wounds, Infectious Diseases. — The contact of the skin, denuded of its outer covering, with decomposing sub-

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birds. He tells us, moreover, that it is not enough to avoid poisonous species, but that discretion should be used in preparing and eating good ones. They change so rapidly, that even the cultivated mushroom, if long kept, is unfit for use. Nor is it enough that they be of good species and fresh; but plenty of salt must be used in their preparation, to neutralize any deleterious property, and pepper and vinegar are also recommended as advantageous."—*Popular Science Monthly.*

stances, irritating plants, such as the poison ivy, poisonous cards, utensils, etc., and of the mucous membrane with matter secreted from diseased surfaces, has produced diseases from which persons have died.

Treatment: Stimulants internally, and mild applications externally, *till the doctor comes.*

NARCOTIC POISONS.

Opium (active principles, morphia, codeia, etc.) in laudanum, paregoric, Godfrey's cordials, Dover's powder, many liniments, soothing syrups, cholera mixtures, Dalby's carminative, etc., is a particularly active poison in the very young and the old.

Antidotes: Strong coffee, aromatic spirits of ammonia (five drops every fifteen minutes till recovered), electricity, cold douches, slapping of the surface by hands or wet towels. *Keep the patient moving if inclined to sleep, and, if possible, in the open air.*

Belladonna (deadly nightshade) in ointments, liniments, and lotions. Its active principle, atropia, is used in solution by oculists as an application to the eye. The leaves and berries of the plant are sometimes eaten by children by mistake.

Antidotes: Cold douches; brandy; paregoric, fifteen drops, or laudanum, five drops, *with care*, every quarter of an hour, with large doses of lime-water; electricity.

Hemlock. — Five varieties are said to be poisonous, and all parts of the plant. The roots of the water hemlock are sometimes mistaken for parsnips. One variety (fools' parsley) is sometimes mistaken for ordinary parsley. The hemlock is common, and grows in hedges and wild places.

Antidotes: Aromatic spirits of ammonia. If much pain and vomiting, ten grains of bromide of potassium every half-hour, or hour, as the case demands.

Stramonium (thorn apple, "Jimson" or "Jamestown weed"). —Found along roadside, and near fences in out-of-the-way places. Seeds sometimes eaten by children.

Antidotes: See Belladonna.

Strychnine, as sold in the shops, is a white powder; bought frequently to poison animals; may be taken by persons by mistake; is also an ingredient of tincture of nux vomica, a medicine.

Antidotes: Chloroform, or ether, inhaled to relieve spasm; cold douches; aromatic ammonia; rectal injection of an infusion of tobacco; artificial respiration.

Prussic Acid. — Hydrocyanic acid, used in a dilute form, medicinally; cyanide of potassium, used to kill moths, butterflies, etc., in laurel water; the meat of peach, cherry, plum, and almond pits, if freely eaten.

Antidotes: See Gases.

Chloroform and Chloral, both, too often used indiscriminately and recklessly by people at large.

Antidotes: Slapping of body, cold douches, electricity, artificial respiration.

Digitalis (foxglove), a garden plant. Its extract used medicinally.

Hyoscyamus (henbane). — Used medicinally.

Antidotes: Same as for Belladonna.

Alcohol. — Used repeatedly, even in so-called moderate amount, is a slow poison. In the young and feeble, it has caused acute poisoning, and even death.

Antidotes: In acute poisoning, emetics, cold douches, coffee, aromatic ammonia, and slapping the soles of the feet.

APPENDIX NOTES.

APPENDIX NOTES.

Arranged according to the pages and paragraphs to which they belong. In the text, reference to these notes is made by letters.

Page **22**, § **33** (*a*.). ***The Human Hand.***— "We ought to define the hand as belonging exclusively to man, corresponding in sensibility and motion with that ingenuity which converts the being who is the weakest in natural defence to the ruler over animate and inanimate nature. . . . The armed extremities of a variety of animals give them great advantages; but if man possessed any similar provisions, he would forfeit his sovereignty over all As Galen long since observed. 'Did man possess the natural armor of the brutes, he would no longer work as an artificer, nor protect himself with a breastplate, nor fashion a sword or spear, nor invent a bridle to mount the horse and hunt the lion; neither could he follow the arts of peace, construct the pipe and lyre, erect houses, place altars, inscribe laws, and, through letters, hold communication with the wisdom of antiquity.' But the hand is not a distinct instrument; nor is it properly a superadded part. The whole frame must conform to the hand, and act with reference to it." — *The Hand.* BELL.

P. **28**, § **40** (*a*.). ***Importance of Conjoint Action of Muscles.***— "The state of equilibration between the muscles performing opposite kinds of movements . . . may be readily illustrated by the part played by the muscles placed before and behind the spine, in maintaining the erect posture of the body. The position is kept up without effort, without even consciousness, by the healthy man whose muscles are well balanced and in good 'tone.' It may be, however, that the same man, after a long day's work over a desk in an ill-ventilated city office, no longer presents that supreme unconsciousness of his muscles and their action, and the stoop of his shoulders and bent head demonstrate to others that the balance is no longer kept, that the tonicity of the morning has passed off, and the wearied muscles are no longer on the watch. And so it is when, in sleep, the muscles are relaxed and gravity asserts its force, so that the head falls forward by its own weight, no longer restrained by the passive counteraction of its 'extensor' muscles. . . . So little is the effort required to keep the body erect, that it is a sign rather of weakness than strength in anyone who exercises an effort to do this. This may seem paradoxical, but it is nevertheless the case; and he who walks 'bolt up-

right,' with his chin in the air and his back as rigid as a plank, is often not a strong but a weak man." — *Personal Appearances* (Health Primer). SIDNEY COUPLAND, M.D.

P. 30, § 43 (*a.*). **Sleep.** — "Animals possessing a well-developed nervous system must, night after night, or day after day, or at least time after time, lay them down to sleep. The salient feature of sleep is the cessation of the automatic activity of the brain. But the condition is not confined to the cerebral hemispheres; all parts of the body either directly or indirectly take share in it. The phenomena of sleep are perhaps seen in their simplest form in the winter-sleep of hibernation, to which especially cold-blooded animals, but also to some extent warm-blooded animals, are subject." — *Text-Book of Physiology.* FOSTER.

P. 30, § 43 (*b.*). **Time to be allotted to Sleep.** — "Where attempts have been made by literary characters to assign a proper period for sleep, they have either been guided by their known capabilities, or by what they have esteemed themselves capable of effecting; or they have been led, in their ignorance of physiology, into Utopian considerations regarding the time *wasted*, as they conceive, in rest. How else can we account for the idea of Jeremy Taylor, that three hours only in the twenty-four should be devoted to sleep? In an equally arbitrary manner, Baxter fixes on four hours, Wesley on six, and Lord Coke on seven. So much depends on the constitution and habits of individuals, that if some were restricted to the period allotted by Baxter, or Taylor especially, their lives could not fail to pay the forfeit. Men of active minds, whose attention is engaged in a series of interesting employments, sleep much less than the lazy and listless. It is probable that, in these cases, sleep is more intense." — *Human Health.* ROBLEY DUNGLISON, M.D.

P. 35, § 50 (*a.*). **The Value of Competitive Sports among Students.** — Recognizing both the value of competitive sports in inducing physical exercise, and the danger, especially to the ambitious, of over-training, a number of the leading colleges and seminaries in this country have well-appointed gymnasiums, with efficient medical directors, who also give instruction in physiology and hygiene. Among the colleges may be mentioned Harvard, Yale, Cornell, Amherst, Wellesley, and Smith. Prof. Edward Hitchcock, M.D., says of the work accomplished at Amherst: "From the beginning of the existence of the department of physical education in Amherst College it has never been the desire to develop the muscular system at the expense of any other part of the body, as is too often understood to be the meaning of physical education or training. This department was not created, nor has it been developed, for the purpose of extraordinary attention to the muscular system. Its sole object has been to keep the bodily health up to the normal standard, so that the mind may

accomplish the most work, and to preserve the bodily powers in full activity for both the daily duties of college and the promised labor of a long life. Indeed, in that particular, the precept of Cicero has been literally followed, namely, that bodily exercise should have for its chief object the development of a capacity for rational work. At the same time, it has been equally desired that the so-called exercises of this department should be mentally as well as physically enjoyed by the students, and not be made a tedious, mechanical, or heavy drill. . . . The results accomplished by this department in Amherst College lead its government to continue its existence, and sustain it on a par with the others."

Dr. D. A. Sargent, Professor of physical training at Harvard, in a paper read before the American Public Health Association, Nov. 14, 1883, says: "Students enter college trained in mind but not in body; and where one fails for want of mental ability, ten break down for want of physical stamina. Many are short in stature for their age, or tall and slender, with a deficiency of muscular strength. Under an appropriate system of physical training, however, they make most rapid advancement, showing that their bodies had been kept in arrears while their brains were developed. Many are ignorant of the first principles of physiology and hygiene, and leave school with acquired defects which are past remedying, but which a little appropriate knowledge and training could have obviated. Not infrequently the students who stood the highest in the preparatory schools are taken with a sort of mental dyspepsia after entering college, and devote most of their energies to physical exercises. This is invariably the case where the preparatory training has been forced and unnatural."

P. 36, § 51 (*a*.). ***Cramp and Palsy from over-use of one set of Muscles.*** — A form of palsy, sometimes known as hammer palsy, occurs from the repeated use of a hammer in scissors-making and forging of knife-blades, 100 blows, it is said, being necessary to forge one blade. In one day a good operator will make 24 dozen blades. "Tailor's palsy," "milker's cramp," and "writer's cramp," are instances of the over-use of certain muscles. In regard to "writer's cramp," Dr. Geo. M. Beard states, after an examination of 125 cases, that "it is far less likely to occur in those who do original work, as authors, journalists, composers, than in those who do routine work, as clerks, book-keepers, copyists, agents, etc."

P. 36, § 52 (*a*.). ***Some of the Results of Improper Muscular Exercise.*** — "Every year a number of middle-aged men, who for years or months have been engaged in the sedentary occupation of a profession, of literature, or of business, at the commencement of the autumn holidays start for the continent or the highlands, and suddenly undertake immense

fatigue in the ascent of Alpine heights, or the no less laborious work of a day on the moors, without the least preparation. So, also, we see every bank holiday, crowds of young men starting off for some tremendous walk, or 'bucket' up the river, utterly unprepared for the task they undertake. Is it to be wondered at that men return complaining that their holiday has done them no good; that, instead of vigor, they complain of exhaustion; that their appetite fails them, their nights are sleepless, their limbs ache, and they are jaded and spiritless? It is the evils produced from this erratic athleticism that give rise to the formidable indictments that from time to time have been urged against vigorous exercise and the pursuit of manly sports, which, if properly managed, and undertaken systematically, are really the foundation of really healthy life." — *Exercise and Training* (Health Primer). C. H. Ralfe, M.D.

"By skilful training, it is quite true that men may be, and are, brought to a fine external standard; but the external development is so commonly the covering of an internal and fatal evil, that I venture to affirm there is not in England a trained professional athlete of the age of thirty-five, who has been ten years at his calling, who is not disabled." — *Health of Rowing Men.* Dr. E. H. Bradford.

How old this experience is, in regard to trained athletes, may be seen by the remark of an ancient medical writer quoted on page 34 of the text.

P. 38, § 54 (*a*.). ***Why Young Women should have Muscular Exercise.*** — "It has been my privilege, for more than twenty-five years, to be intimately associated with young women, either as teacher in the school room in the earlier years, or as medical practitioner, or teacher of hygiene, during the latter ones, and every day's added experience only confirms me in the position I have occupied from the first relative to the various forms of nervousness which characterize our sex. That position affirms that the best possible balance for a weak, nervous system, is a *well-developed muscular system.* Weak, shaky, hysterical nerves always accompany soft, flabby muscles; and it is a mournful fact that the *majority of the young women* whom I meet in schools are notably deficient in muscular development." — Dr. Mary J. Studley.

P. 39, § 56 (*a*.). ***Good Effects of Certain Forms of Exercise.*** — "Dancing is a cheerful and useful exercise, but has the disadvantage of being used within doors, in confined air, and often in dusty rooms and at most unseasonable hours. Practised in the open air, and in the daytime, as is common in France, dancing is certainly an invigorating pastime; but in heated rooms, and at late hours, it is the reverse, as these do more harm than can be compensated by the healthful exercise of the dance." — Dr. Combe.

"The bicycle is evidently the *coming horse of the future,* fully compre-

hending all the advantages of horse-back riding as a healthful exercise, and excelling in all the pleasures of the country tourist. The velocipede of a few years ago is among the things that were, although it did good service for the time in straightening the backs and filling the chests of school-boys and collegians, at some risk, on account of defects in construction; but those defects have all been surmounted in the bicycle, and the risk of injury from riding is really less than that of the horse." — Dr. A. N. Bell, in *Sanitarian.*

"Five minutes of pretty brisk exercise on the bars, or with dumb-bells, or in any other moderate way, repeated several times during the morning, will have a wonderfully good effect in promoting full respiration, purifying the blood, and in nourishing the muscular system. The writer often picks up a chair, or any other moderate weight at hand, and after five minutes' play therewith, over the head or otherwise, can feel that the muscles of the arm have, in that short time, secured an extra supply of blood, which tends at once to nourish them, and to diffuse and equalize the circulation." — *Popular Science Monthly.* Dr. Richard McSherry.

"It is surprising how short a period of vigorous exercise, daily, will develop an approach to the maximum of muscular power." . . . "I believe that one hour a day of vigorous exercise, with proper attention to diet, will efficiently train a well-formed and healthy man for any reasonable feat of strength or endurance." — *The Source of Muscular Power.* Austin Flint, Jr., M.D.

P. **45,** § **63** (*a*). ***The Production of Corns and Callous Spots.*** — It is a law that *interrupted* pressure produces hypertrophy, *i.e.*, an increase of nourishment or supply, resulting in an increase of size, and *constant* pressure produces atrophy, or a want of nourishment or supply, resulting in a decrease of size. By the interrupted pressure exerted in ordinary avocations, the epidermis of the palm and soles becomes much thickened. "Callous" spots upon the knees of shoemakers and the chests of other workmen, are to be ascribed to the interrupted pressure upon the respective parts of lapstone and hammer, "brace and bit," "burnishers," "breast-drills," etc. Corns, in like manner, are the result of the irritation of certain portions of the epidermis lying near to the bones, by the interrupted pressure from shoes which are either too tight or too loose. On the other hand, the constant pressure of shoes, bandages, etc. (*i.e.*, by night and day), will cause atrophy, as may be seen in the deformities of the feet of certain Chinese girls.

P. **46,** § **66** (*a*). ***The Vast Number of Pores of the Skin, and of its Drainage Tubes.*** — "Taken separately, the little perspiratory tube, with its appended gland, is calculated to awaken in the mind very little idea of the importance of the system to which it belongs; but when the vast

number of similar organs composing this system are considered, — for it includes the sebiparous glands, which are also agents in perspiration, — we are led to form some notion, however imperfect, of their probable influence on the health and comfort of the individual. I use the words 'imperfect notion' advisedly, for the reality surpasses imagination, and almost belief. . . . I counted the perspiratory pores on the palm of the hand, and fonnd 3528 to a square inch. Now, each of these pores being the aperture of a little tube of about a quarter of an inch long, it follows that in a square inch of skin on the palm of the hand there exists a length of tube equal to 882 inches, or 73½ feet. . . . I think that 2800 might be taken as a fair average of the number of pores in the square inch of surface, and 700, consequently, of the number of inches in length of the tubes. Now, the number of square inches of surface in a man of ordinary height and bulk is 2500; the number of pores, therefore, 7,000,000; and the number of inches of perspiratory tube, 1,750,000; that is, 145,833 feet, or 48,600 yards, or nearly *twenty-eight miles.*" — *Diseases of the Skin.* WILSON.

P. **49,** § **71** (*a*.). ***Causes of Baldness. How to maintain the Health of the Hair.***— Baldness, which, at the time of writing, is very common among middle-aged men, as well as among the old, results from local or general causes, or both combined, from the pressure of tight hats and caps cutting off the supply of blood, from the lack of air, by wearing head coverings too constantly, from diseases of the scalp, such as animal and vegetable parasitic growths, from severe inflammation, as erysipelas, or any exhausting disease, and from worry, age, or hereditary weakness in the parts. So-called "hair-restorers" are only valuable in so far as they stimulate the activity of the scalp. Some of them, however, including some hair-dyes, have been known to destroy the health of the hair, to injure the scalp, and to impair the general health. A too frequent use of a fine comb increases the activity of the skin, and causes the epidermis to throw off numerous cells, which, combined with the oil of the hair, dirt, etc., create "dandruff." Frequent brushing with a good stiff brush strengthens and improves the hair by invigorating the scalp, and increases the amount of sebaceous material, or "natural hair-oil." Most people have, therefore, in their power, a natural ointment which is far superior to pomades and artificial hair-oils. An occasional cleansing of the scalp with water in which are a few drops of ammonia water, followed by an application of a small amount of vaseline, the whole being preceded by a thorough brushing, is far better than the use of oils and grease, which may be of doubtful utility, or positively harmful.

P. **51,** § **78** (*a*.). ***The Relief of Thirst through the Skin.***— "It has been frequently remarked that the sensation of thirst is always least pressing

in a moist atmosphere, and that it may be appeased to a certain extent by baths. . . . We could hardly account for an actual alleviation of thirst by immersion of the body in water, unless we assumed that a certain quantity of water had been absorbed. A striking example of relief of thirst in this way is given by Capt. Kennedy, in the narrative of his sufferings after shipwreck, when he and his man were exposed for a long time without water, in an open boat. With regard to his sufferings from thirst, he says: 'I cannot conclude without making mention of the great advantage I derived from soaking my clothes twice a day in salt water, and putting them on without wringing. . . . So very great advantage did we derive from this practice, that the violent drought went off, the parched tongue was cured in a few minutes after bathing and washing our clothes; at the same time we found ourselves as much refreshed as if we had received some actual nourishment.'" — *Text-Book of Physiology.* FLINT.

P. 60, § 94 (*a*.). ***Sun Baths among the Ancients.*** — "According to Plutarch, when the youthful Alexander visited Diogenes at Corinth, he found the famous cynic tranquilly lying in the sun The warrior affably saluted the philosopher, and asked if he could do him any service. 'Only stand a little out of my sunshine,' replied Diogenes. This incident occurred when this renowned Athenian had reached the age of 'three-score and ten' — long past the eccentric days of his life in a tub, and his daylight lantern-searches for an honest man; and there is good reason to suppose that he really valued the invigorating solar rays more than any boon Alexander could give. Nor was he alone in his devotion to sunshine, for, as we learn from Pliny, it was a common practice in Greece for old men to recruit their energies, both mental and physical, by exposing themselves naked in the sun — a fact which Hippocrates might have had in mind when he wrote: 'Old men are double their age in winter, and younger in summer.'" — DR. C. E. ANGELL, in *The Sanitarian.*

P. 64, § 102 (*a*.). ***The Use of Corsets in Early Times.*** — "The first mention of stays that I have ever found is in the letters of dear old Synesius, Bishop of Cyrene, on the Greek coast of Africa, about four hundred years after the Christian era. He tells us how, when he was shipwrecked on a remote part of the coast, and he and the rest of the passengers were starving on cockles and limpets, there was among them a slave girl out of the far East, who had a pinched wasp-waist, such as you may see on the old Hindoo sculptures, and such as you may see in any street in a British town. And when the Greek ladies of the neighborhood found her out, they sent for her from house to house, to behold, with astonishment and laughter, this new and prodigious waist, with which it seemed to them it was impossible for a human being to breathe or live; and they petted the poor girl, and fed her, as they might a dwarf or a

giantess, till she got quite fat and comfortable, while her owners had not enough to eat. So strange and ridiculous seemed our present fashion to the descendants of those who, centuries before, had imagined, because they had seen living and moving, those glorious statues which we pretend to admire, but refuse to imitate." — *Health and Education.* Rev. Charles Kingsley.

P. 65, § 104 (*a.*). ***Why Improper Shoes are Worn.***— "It is amazing the misery the people of civilization endure in and from their shoes. Nobody is ever, as they should be, comfortable at once in them; they hope, in the long run, and after much agony, and when they are nearly done, to make them fit, especially if they can get them once well wet, so that the mighty knob of the big toe may adjust himself, and be at ease. For my part, if I were rich, I would advertise for a clean, wholesome man, whose foot was exactly my size, and I would make him wear my shoes till I could put them on and not know I was in them. Frederick the Great kept an aide-de-camp for this purpose; and, poor fellow, he sometimes wore them too long, and got a kicking for his pains. Why is all this? Why do you see every man's and woman's feet so out of shape? Why are there corns, with their miseries and maledictions? Why do nails grow in, and sometimes have to be torn violently off? All because the makers and users of shoes have not common sense and common reverence for God and his works enough to study the shape and motions of that wonderful pivot on which we turn and progress. Because Fashion says the shoe must be elegant, must be so and so, and the beautiful living foot must be crushed into it, and human nature must limp along Princes Street, and through life, natty and wretched." — Dr. John Brown, author of "*Rab and his Friends.*"

P. 70, § 111 (*a.*). ***Some of the Risks attending the Use of Unclean Clothing.***— "Unclean clothing is sometimes a direct means of conveyance of disease. The unclean fabric becomes saturated with poisonous substances, with the fumes of tobacco, for instance, and holds its wearer in a persistent atmosphere charged with unwholesome vapor. Still more seriously it becomes the medium of the poisons of the spreading diseases. I could cull from my note-books many examples of this last-named danger, but must be satisfied to mention one or two striking and brief illustrative facts. I have known scarlet fever carried by the clothing of a nurse into a healthy family, and communicate the disease to every member of the family. I have known cholera to be communicated by the clothes of the affected person to the women engaged in washing the clothes. I have known small-pox conveyed by clothes that had been made in a room where the tailor had by his side sufferers from the terrible malady. I have seen the new cloth, out of which was to come the riding-habit for some innocent child to rejoice in as she first wore it,

undergo the preliminary duty of forming part of the bedclothing of another child stricken down with fever. Lastly, I have known scarlet fever, small-pox, typhus, and cholera, communicated by clothing contaminated in the laundry." — *Diseases of Modern Life.* B. W. RICHARDSON, M.D.

P. **87**, § **127** (*a*.). ***Why Tartar Forms, and Why Teeth sometimes Decay Readily.*** — The temperature of the mouth is about 100° Fahr. Its secretions should be alkaline; but, owing to the heat and moisture in the mouth, and the retention of particles of food between the teeth, they are frequently acid. The decomposed food, together with the acid mucus, dries and hardens into "tartar" (so-called because of its resemblance to the article precipitated from wine in wine-casks), a concretion which, if not removed, pushes its way towards the roots, causing inflammation of the gums, and decay of the teeth. The pulp cavity is also opened up through cracking of the enamel. Non-digested food in the stomach or small intestine sometimes causes the secretions of the mouth to be acid, and so injurious to the teeth. Sudden variations in the temperature of food or drink affect or impair the enamel.

P. **95**, § **138** (*a*.). ***The Importance of Thorough Chewing of Food.*** — The value of insalivation in connection with mastication is appreciated when we consider how difficult it is to chew dry substances like crackers until they are moistened. It is also almost impossible to swallow substances which are very dry. The value of a thorough *comminution of food*, in making it more soluble, is shown by a comparison of the length of time it takes for a lump of sugar to dissolve, with that consumed by a similar lump broken into fine particles, in the same amount of water. Imperfect chewing, and the absence of good, sound teeth, produce many a dyspeptic. On the other hand, the filling of teeth, or the substitution of a good artificial set for teeth which are worn out and decayed, has often proved to the dyspeptic his only means of cure. It is well known to veterinary surgeons that horses sometimes lose their appetite and strength on account of broken or irregularly worn teeth, which prevent them from chewing their food.

Old people and young children are very apt to bolt their food. As they do not chew well, their food should be thoroughly minced for them.

P. **97**, § **143** (*a*.). ***Time occupied in the Digestion of Various Articles of Food.*** — In 1822, Alexis St. Martin, eighteen years of age, a *voyageur* in the employ of the American Fur Company, was wounded in the left side, the ball perforating the stomach. Through an opening which did not heal entirely for a number of years, Dr. Beaumont of the U. S. Army was enabled to watch the digestion of foods in the stomach. The following extract from a table prepared by Dr. Beaumont shows the digestibility of various foods. The estimates may be considered as approximative only as to the

generality of people, being founded upon an isolated case; still, experiments have been made upon animals which tend to confirm those made upon St. Martin.

	Hours.	Min		Hours.	Min
Pigs' feet, soused (boiled)	1	00	Mutton (roasted)	3	15
Tripe, soused (boiled)	1	00	Eggs (hard boiled)	3	30
Soup, barley (boiled)	1	30	Eggs (fried)	3	30
Trout, Salmon, fresh (fried)	1	30	Potatoes, Irish (boiled)	3	30
Venison steak (broiled)	1	35	Oysters (stewed)	3	30
Milk (boiled)	2	00	Beets (boiled)	3	45
Cabbage, with vinegar (raw)	2	00	Green corn and beans (boiled)	3	45
Eggs, fresh (raw)	2	00	Salmon (boiled)	4	00
Apples, sour, mellow (raw)	2	00	Soup, beef, vegetables, and bread (boiled)	4	00
Milk (raw)	2	15	Duck, barn-yard (roasted)	4	00
Turkey (roasted)	2	30	Heart, animal (fried)	4	00
Eggs, fresh (soft boiled)	3	00	Pork, salt (fried)	4	15
Beefsteak (broiled)	3	00	Veal (fried)	4	30
Mutton, fresh (boiled)	3	00	Cabbage (boiled)	4	30
Soup, chicken (boiled)	3	00	Duck, wild (roasted)	4	30
Bread, corn (baked)	3	15	Pork, fresh (roasted)	5	15
Oysters, fresh (roasted)	3	15			

P. 105, § 152 (*a.*). *Relief of Constipation.* — In view of the fact that constipation or a sluggish condition of the bowels is very common, it has been repeatedly urged by instructors that books upon Physiology and Hygiene ought to give some hints for its relief. The following will neither answer for all persons, nor always take the place of medicinal measures, which should come from the attending physician: 1st. Daily muscular exercise, especially walking, if not carried beyond the strength of the individual. Too much exercise may aggravate the trouble. 2d. A cold bath before breakfast for those who can stand it. 3d. Moist compresses (*i.e.*, several thicknesses of cloth) applied for two or three hours daily over the abdomen. 4th. Daily kneading of the bowels, especially in the course of the large intestine. 5th. A glass of hot or cold water before breakfast, or water in which a few cloves have remained over night, or in which there is just enough salt to give a *slight* saline taste. 6th. Fruit; oranges, apples, bananas, or grapes, before or at breakfast; figs, dates, and other similar fruits throughout the day, *i.e.*, in small quantity, or stewed fruit for supper, or a baked apple before retiring. 7th. Oatmeal, Indian meal, Graham bread and Graham crackers, sardines, coffee (and with some persons, tea), molasses, and molasses cake, zwieback, etc.

While the above measures, used with discrimination, are of value, it is but right to state that many persons, especially those who take but little exercise, are liable to carry the hygienic treatment to extremes, and to injure their digestive organs by much indigestible food.

P. 107, § 157 (*a.*). *The Effects of too much Animal Food.* — "Dominie Sampson was another man after Meg Merriles had compelled him to eat some of the contents of her stew-pot; and Liebig compares the

mental attitude of three persons, — one of whom has had a substantial meal of meat, a second who has dined on fish, and the third who has had some bread and an onion. The beef of the British warrior has always been counted as an element in his bravery. There are, then, two very potent reasons why we eat too much albuminous food; one, because it is pleasant to eat, and another, because it produces an agreeable mental condition. But when we have too much of a good thing, and the blood is surcharged with waste, then the mental attitude is unpleasantly affected; there is the irascibility of gout, which is not merely the effect of pain; and the melancholy of biliousness." — *Food for the Invalid.* FOTHERGILL AND WOOD.

P. **108,** § **158** (*a.*). ***Methods of preserving Food for Transportation.*** — The value of proper canning, and of other methods of preserving food, is well illustrated in the detailed instructions as to provisions, given by the Navy Department to the Commander of the Greely Relief Expedition in the spring of the present year (1884). Macaroni and vermicelli, bacon, preserved cranberries, etc., are to be packed in air-tight wooden kegs; marrow beans, dried green peas, dried Lima beans, sweet corn, pork, salt beef, etc., in well-seasoned tight half-barrels; baking-powder, compressed vegetables, mince-meat, evaporated fruit, fried potatoes, roast chicken and turkey, head cheese, sausages, apple and peach butter, candied lemon-peel, figs, tamarinds, cooked corn, beef, preserved beef and mutton, oysters raw and fried, sardines, butter, etc., in hermetically sealed tins; smoked and dried meats well covered with canvas. Fried oysters, and eggs (boiled 20 minutes), are to be put into cans and covered with hot lard. "The special mackerel and special salmon shall be of the best quality, and warranted to keep two years."

Dangers arising from Improper Canning of Food. — The following is a summary of a paper read by Dr. J. G. Johnson before the New York Medico-Legal Society, Feb. 9, 1884, on *Canned Goods — the Dangers to which Consumers are Exposed:* —

"In the canning of food, the can is filled, and placed in boiling water while the cap is soldered on, a hole having been punched in it, through which the air escapes. After which, the hole is soldered up. If the process has been properly performed, when the can becomes cold, the heads sink in and remain sunken. If decomposition begins, the gases which form cause the heads to bulge. To the trade, such cans are known as 'swells.' It has been a trick of unscrupulous dealers to buy the 'swells,' punch a second hole, and heat the contents a second time. This process is known as 'reprocessing,' and has been repeated in certain instances four times. While food from such cans is unfit to eat, a method sometimes employed of sealing cans affords greater danger. It is much greater, 'because it involves a most deadly corrosive poison, the most deadly

known to science, muriate of zinc.' There are three amalgams that may be used in sealing up cans with solder. They are resin, oil, and muriate of zinc. The two former are harmless, but comparatively slow; the latter is faster, but fraught with danger. . . . Muriate of zinc is zinc dissolved in muriatic acid, and the amalgam contains as much of the metal as the acid will accept. It is laid in a groove on the top of the can by boys with brushes; the cap is placed over it, and a very hot iron is applied to melt the amalgam. The zinc holds the cap; the acid may — practically must — drop into the preserve. Or the careless boy may overdo the application and drop some of it into the tin. The contents then become poisonous in the highest degree. The fact is so well known, that in the State of Maryland, where canning is a staple industry, the use of muriatic solder is forbidden by law. . . . The intelligent purchaser will not buy a can of goods in which the brown streak of resin is not visible at the soldering point. To deceive him, it is alleged the canners have adopted the habit of 'bronzing' the tops of cans to conceal the absence of the resin stain. It is fair to infer that bronzed cans are soldered with muriate of zinc amalgam."

The paper concludes with the following suggestions: —

"Every cap should be examined, and, if two holes are found in it, send it at once to the Health Board, with the contents and the name of the grocer who sold it Reject every article of canned food that does not show the line of resin around the edge of the solder on the cap, the same as is seen on the seam at the side of the can 'Standard,' or first-class goods, have not only the name of the factory, but also that of the wholesale house which sells them, on the label. 'Seconds,' or doubtful or 'reprocessed' goods, have a 'stock label' of some mythical canning house, but do not have the name of any wholesale grocer on them. Reject all goods that do not have the name of the factory, and also the name of some wholesale firm, on the label. A 'swell," or decomposing can of goods, can always be detected by pressing in the bottom of the can. A sound can pressed will give a solid feel. When gas from the decomposition of the food is inside the can, the tin will rattle by pressing up the bottom as you displace the gas in the can. Reject every can that shows any rust around the cap on the inside of the head of the can. If housewives are educated to these points, then muriate of zinc amalgam will become a thing of the past, and dealers in 'swells' have to seek some other occupation."

P. **110,** § **161** (*a*.). ***Use of Fat in Cold Climates.*** — The accounts given by travellers of the amount of food, and especially of fat, eaten by the inhabitants of the frigid zone, are almost incredible. The Russian Admiral, Saritcheff, tells of a man who ate in his presence, at a single meal, twenty-eight pounds of boiled rice and butter. "Sir John Franklin tried how much fat an Esquimaux boy could consume: fourteen

pounds of tallow candles quickly disappeared; and Sir John closed the experiment with a piece of fat pork, as he began to feel apprehensive for his stores. Oil is a luxury greedily devoured by the northern races, as was amusingly proven in a seaport town some years ago. The town was lighted by oil lamps, and the inhabitants remarked that they went out for several successive nights; at last it was discovered that some Russian sailors in the harbor climbed the lamp-posts and drank the oil." — *Lectures on Public Health.* MAPOTHER.

P. **110,** § **161** (*b.*). *Use of Fat in Hot Climates.* — "Consider how olive-oil is used in the warm parts of Europe, and how ghee is used in India, in order to satisfy yourself that oily matter may be taken with facility in hot countries as well as in cold. You hear nothing about indigestion; you find that a bad olive harvest or a scant supply of ghee is a great national calamity. A Hindoo servant of a friend who kept up his Indian habits of eating in London, has often told me that nothing would make up for a deficiency of ghee or butter, and that this was the common experience of his countrymen at home or away from home. He looked upon a sip of ghee in very much the same light as that in which his fellow-servants looked upon a draught of beer. 'Wine is good, but oil is better,' said a peasant to the courier who was with me in Andalusia; and after gulping down a large mouthful of olive-oil, and smacking his lips more than once, the expression of his countenance was an apt illustration of the meaning of the Scriptural text which speaks of oil as making 'the face to shine.' Indeed, it may be taken for granted that oil may be used in large quantities throughout the year in the hot olive-growing countries of the south of Europe, not only without making people bilious, but with unmistakable benefit." — *London Practitioner.* "A Few Words About Eatables." C. R. RADCLIFF, M.D.

P. **114,** § **169** (*a.*). *Fasting.* — "Without something to eat or drink, man will not live beyond a few days, or at most a week. Access to water, however, makes a great difference. There is a well-known case of an Ayrshire miner who lived twenty-three days, buried in a coal mine, without swallowing anything but small quantities of chalybeate water sucked through a straw. He had the advantage of being shut up in a contaminated atmosphere, which, by diminishing nervous sensibility, lessened the cravings of hunger. Berard quotes the example of a convict who died of starvation after sixty-three days, but in this case water was taken. Cases of alleged fasting longer than this are certainly due to exposure. The insane appear to bear fasting better than those in their sober senses; and, in some morbid conditions of the body, nourishment may certainly be done without for a surprising length of time. Animals have an advantage over man, so far as living without food is concerned." — *Cassell's Magazine.*

P. **115**, § **171** (*a.*). ***Salt; its Importance.*** — "Animals will travel long distances to obtain salt; men will barter gold for it; indeed, among the Gallas and on the coast of Sierra Leone, brothers will sell their sisters, husbands their wives, and parents their children, for salt. In the district of Accra, on the gold coast of Africa, a handful of salt is the most valuable thing upon earth after gold, and will purchase a slave or two. Mungo Park tells us that with the Mandingoes and Bambaras the use of salt is such a luxury that to say of a man, 'he flavors his food with salt,' it is to imply that he is rich; and children will suck a piece of rock-salt as if it were sugar. No stronger mark of respect or affection can be shown in Muscovy, than the sending of salt from the tables of the rich to their poorer friends. In the Book of Leviticus it is expressly commanded as one of the ordinances of Moses, that every oblation of meat upon the altar shall be seasoned with salt, without lacking; and hence it is called the Salt of the Covenant of God. The Greeks and Romans also used salt in their sacrificial cakes; and it is still used in the services of the Latin church — the '*parva mica*,' or pinch of salt, being, in the ceremony of baptism, put into the child's mouth, while the priest says, 'Receive the salt of wisdom, and may it be a propitiation to thee for eternal life.' Everywhere, and almost always, indeed, it has been regarded as emblematical of wisdom, wit, and immortality. To taste a man's salt, was to be bound by the rites of hospitality; and no oath was more solemn than that which was sworn upon bread and salt. To sprinkle the meat with salt was to drive away the devil; and to this day nothing is more unlucky than to spill the salt." — *On Food.* LETHEBY.

P. **120**, § **178** (*a.*). ***The Amount of Nitrogen and Carbon in Various Articles of Food.*** — Table adapted to this book, from a chart by Charles Ekin, F.C.S., giving the per cent. of carbon and nitrogen in different articles of food in common use.

	N.	C.		N.	C.
Gelatine and Isinglass	18.0	50.0	Cocoa Nibs	1.4	68.5
Cheese	4.5	37.8	Bacon (dried)	1.3	54.0
Lean Meat	3.7	13.2	Rice	0.8	36.0
Lentils	3.7	37.3	Milk	0.7	6.8
Peas	3.5	33.7	Parsnip	0.3	8.6
Haricot Beans	3.5	38.0	Cabbage	0.3	2.6
Butcher's Meat (free from bone)	3.3	23.2	Potato	0.2	11.1
Pork (fresh)	2.8	22.0	Turnip	0.2	5.2
Egg	2.4	16.6	Carrot	0.2	5.4
Fish (fresh)	2.4	9.6	Butter	0.2	68.0
Oatmeal	2.2	35.0	Suet and Fat	0.0	79.0
Flour	2.1	39.2	Loaf Sugar	0.0	42.5
Barley Meal	2.0	40.5	Arrowroot	0.0	42.8
Rye	2.0	38.3	Apples	0.0	5.8
Bread	1.5	23.9			

P. **120,** § **178** (*b.*). ***The Daily Ration of Food.*** — The estimates of the necessary quantity of food given in the text are those of the physiologist Moleschott, and are somewhat different from those given by Dalton, who says that the daily ration for a healthy man, taking free exercise in the open air, and living exclusively on bread, fresh meat, and butter, with coffee and water for drink, is

Meat	16 oz.	or	1.00	lb. avoirdupois.
Bread . . .	19 oz.	"	1.19	" "
Butter or Fat .	$3\frac{1}{2}$ oz.	"	0.22	" "
Water . . .	52 fl. oz.	"	3.38	" "

The daily ration of the United States soldier is a liberal one, so much so that "company funds" during the late war were enriched by money allowed for the surplus retained. It is as follows: —

Bread or Flour	22 oz.
Fresh or Salt Beef (or Pork or Bacon, 12 oz.)	20 oz.
Potatoes (three times a week)	16 oz.
Rice	1.6 oz.
Coffee (or Tea, 0.24 oz.)	1.6 oz.
Sugar	2.4 oz.
Beans	0.64 gill.
Vinegar	0.32 gill.
Salt	0.16 gill.

P. **121,** § **180** (*a.*). ***Fresh Meat as a Preventive of Scurvy.*** — Dr. T. J. Turner, Medical Director, U. S. Navy, in an article in *The Sanitarian*, April, 1884, shows that an ample supply of fresh meat, *i.e.*, from animals killed on the spot, such as the walrus and narwhal, is superior to any form of preserved meat in the prevention of scurvy, in that it furnishes the necessary salts and acid (probably lactic acid). In fact, he speaks of fresh raw animal food as the best anti-scorbutic. Where it cannot be obtained in sufficient quantity, he suggests that a mixture of sodium, potassium, and calcium phosphates be added to preserved and cooked meats or other foods, and that lactic acid be added to the vinegar used as a condiment.

P. **123,** § **185** (*a.*). ***Importance of Knowledge as to Economical as well as Nutritious Food.*** — "In this country, at the present time, the masses do not understand how and where to buy very nutritious foods for the least money. Personal instruction, cheap cookery books, health primers, and tracts, are not as common in this country as in some others; in England, for example. By such means, the laboring classes, whose peculiar demand for cheap and wholesome food it should be the aim of the philanthropist as far as possible to satisfy, are taught how articles, which, because coarse and regarded as unwholesome, are very cheap, can be converted by the culinary art into savory and healthful dishes. By the circulation of health

treatises, they learn, also, that the actual food wants of man are small, and what those wants are, and what foods will best supply them. Having thus been taught the true physiological needs, and when and how to procure their food, the children of toil will be blessed with knowledge that will bring comfort and health to their homes, and preserve the life of the struggling father to his family and their lives to him."

How Good Cooking Pays. — "Foul air and overcrowding would, however, be less fatal in its results were food understood. The well-filled stomach gives strange powers of resistance to the body. . . . Happily, to know an evil is to have taken the first step in its eradication. . . . To have made cooking and industrial training the fashion, is to have cleared away the thorny underbrush on that debatable ground, the best education of the poor. . . . That cooking schools and the knowledge of cheap and savory preparation of food must soon have their effect on the percentage of drunkards no one can question. Philanthropists may urge what reforms they will — less crowding, purer air, better sanitary regulations — but this question of food underlies all. The knowledge that is broad enough to insure good food, is broad enough to mean better living in all ways. . . . One woman, who has learned in any degree to order her own home and life aright, will be more a power with those among whom that life passes than a dozen average preachers." — *How to Help the Poor.* Mrs. James T. Field.

P. **123**, § **186** (*a.*). ***The High Calling of a Good Cook.*** — "Bad cooking is the rule, good cooking the exception. The truly artistic cook — the veritable *cordon bleu* — is a rare bird with us. The calling of a man cook ranks a little above that of the waiter-man; it is, perhaps, nearly up to that of a first-rate barber or hair-dresser. Almost invariably the professional male cook is an exotic production, — generally imported from France, — the calling being beneath the dignity of a native American not of African descent. A hired woman cook holds her head somewhat higher than the waitress and laundress, not so much on account of her superior rank, as from certain advantages of her position. The responsibility of cooking, however, in small households, either rests with a maid of all work, or it is assumed by the mistress, whose qualifications are derived from perhaps a little experience, the possession of some family receipts, and, possibly, a cook-book. I shall not linger on this topic, but leave it with a few assertions. If alimentation have the importance and dignity which I have claimed for it; if appetite and taste are to be estimated by their physiological relations, the functions of a cook are of a higher grade than that denoted by the facts just stated. A skilful cook, male or female, is entitled to as much distinction, at least, as a clever mechanic. The calling should be reckoned an honorable one. The science

and the art of cooking should be taught by competent professors, and should be embraced in the curriculum of female schools. More than this, here is a field for discoveries, inventions, and continued progress. To devise new combinations and culinary processes is a worthy object of study and experiment. He who may originate a new article of diet, palatable, digestible, and nutritious, by utilizing materials which are readily available, deserves something of the credit belonging to one who makes two blades of grass grow where but one grew before." — *Food in its Relations to Personal and Public Health*, a paper read at the annual meeting of the American Public Health Association, 1876, by Austin Flint, M.D.

P. **128,** Note **1** (*a.*). ***How to Utilize Remnants of Food.*** — "Nothing so well symbolizes the economical habits of continental Europe, and especially France, as the *pot au feu*. This is an iron pot kept constantly simmering upon the fire, into which is put from day to day all the wholesome remnants of food which in this country are thrown away. Our people, in their magnificent way of doing things, never stop to consider how much nutriment adheres even to well-picked bones of porter-house steaks, mutton-chops, ribs of beef, legs of mutton, etc. All these, and many things besides, are put into the *pot au feu;* water, seasoning, and fragrant herbs are added as required, and the constant simmering, — a solvent for even the toughest of Texan beef, — extracts every particle of marrow even, and the bones come out as clean and white as if they had been bleached in the sun. Among the common people, more than half of the nutriment of the day comes from *pot au feu*, and if any member of the family comes home at an unusual hour hungry, it affords at all times a meal at once warm and wholesome. This explains how, as Hugh McCulloch tells us, the 40,000,000 of France could live on what the 40,000,000 of America throw away; and when we consider the wretched cookery that prevails in this country, it is not too much to affirm that they live twice as well as do our farmers and day-laborers." — *Lancaster Farmer*.

P. **129,** § **188** (*a.*). ***The too Frequent Use of Meat and Meat Extracts.*** — Undoubtedly, meat is too frequently used to the exclusion of other foods. For children, meat once a day is sufficient. The recent report of Dr. D. M. Camman, Physician to the Orphans' Home and Asylum of the Protestant Episcopal Church, New York City, in the *N.Y. Medical Journal*, March 29, 1884, shows that for the last *twenty-five years*, the children in that institution under eight years of age have received *no meat*, but in place of it an abundance of milk, yet the health of the children has been unusually good. The eating of meat three times a day, except by persons who do *very hard physical* work, is to tax the eliminating organs. The effects of too much meat combined with too little exercise are frequently manifested in the "biliousness," headache, gout, etc., which befall persons who "live

high." Few people need meat, ordinarily, more than twice a day, and in summer more than once a day. The sick are often inclined to consider meat, or meat teas, soups, and broths, as the most nutritious foods they can take, and hence sometimes delay their recovery by overtaxing the liver and kidneys.

P. **129**, § **188** (*b*.). ***The Adaptation of Food to the Digestive Powers.*** — "Nature has provided for the young of the mammalia, in milk, food containing all the elements of nutrition in a semi-prepared state, which only requires a very short time for its thorough transformation into chyle. The same may be said of all oviparous animals, for they live on the contents of the egg in the early stage of their existence. Nature has evidently wished to spare the delicate organs of the young, in the earliest period of life, the labor which they are destined later in life to undergo, in the elaboration of their food.

"The stomach of the strong man, of the navvy, of the drayman, may be compared to a quartz-crushing machine. It wants quartz, that is, strong, coarse foods, bread, bacon, pork, beef, to work upon, to crush. To give it eggs and milk would be like putting trifle or blanc-mange into the quartz-crushing machine; it would merely put it out of gear. On the other hand, the child, the delicate woman, the dyspeptic, the invalid, have stomachs that may be compared to a light chocolate-crushing machine. Quartz they cannot crush, and the attempt would ruin the machine, although it may be perfectly equal to crushing light things, such as chocolate, eggs, etc. In sickness and in deranged health the digestive organs lose their tone and powers, and should be treated as Nature treats the young; that is, the kind of nitrogenous food should be given which entails the least work on the part of the stomach. It is weakened, its muscular and secreting powers are diminished, and it no longer requires for its health many hours of rude exercise daily." — *Nutrition in Health and Disease.* BENNETT.

P. **129**, § **190** (*a*.). ***The Relative Value of Various Meats.*** — An inquiry among various charitable institutions shows that beef is relished best, and in the form of stews; next, mutton and pork; then fish, especially in the form of chowder. Of late years, considerable has been said against the use of pork, and undoubtedly much of the pork sold to and used by the poor is unfit to eat. But if pigs are fed largely upon corn, and are kept well cleansed and housed, they yield healthy pork. The flesh of all animals is affected by transportation in badly ventilated cars, and even the method of killing influences the quality of the meat. Fish, for instance, is said to be more palatable and nutritious if killed immediately after being caught, instead of being allowed to die slowly.

P. **130,** § **192** (*a.*). ***The Amount of Albuminoids does not Determine the Nutritious Value of Foods.*** — We have before pointed out that the relative amount of albuminoids in foods does not determine as to the digestibility and nutritious value of the foods in question. This is as true in regard to fish as to other articles. "What is *in general* the proper proportion in which food constituents should be taken is not easily ascertained and has been variously stated. And in the case of each individual it undergoes continual modification. No one knows this better than the poor dyspeptic, who, having largely destroyed by his irregularities the guiding instinct of a healthy appetite, is compelled to study most carefully what food he may venture to take and what he must avoid."

P. **130,** § **193** (*a.*). ***Raw Oysters.*** — "'Our practice in regard to the oyster is exceptional, and furnishes a striking example of the general correctness of the popular judgment on dietetic questions. The oyster is almost the only animal substance which we eat habitually and by preference in the raw or uncooked state; and it is interesting to know that there is a sound physiological reason at the bottom of this preference. The fawn-colored mass which constitutes the dainty of the oyster is its liver, and this is little less than a mass of glycogen; associated with the glycogen, but withheld from actual contact with it during life, is its appropriate digestive ferment — the hepatic diastase. The mere crushing of the dainty between the teeth brings these two bodies together, and the glycogen is at once digested, without other help, by its own diastase. The oyster, in the uncooked state, or merely warmed, is, in fact, self-digestive. But the advantage of this provision is wholly lost by cooking, for the heat employed immediately destroys the associated ferment, and a cooked oyster has to be digested, like any other food, by the eater's own digestive power.' This graphic description by Dr. Roberts tells us how it is that oysters *au naturel* are so much in vogue for invalids, as they deservedly are. Also, why oysters should not be cooked in oyster sauce, but put into the prepared sauce just as it comes to table. Why, as King Chambers insists, in a beef-steak pudding, the oysters should not be cooked, but a flap of the paste raised, and the oysters popped in, just as the pudding is served. In making oyster pâtés, the paste is cooked in bread-crumbs, which is then taken out and the oysters put in; after which, the pâtés are just warmed, and no more, and then brought up to the dinner table. The idea that long cooking increases the digestibility of food is not always correct." — *Indigestion and Biliousness.* FOTHERGILL.

P. **131,** § **194** (*a.*). ***Decomposing Food to be Guarded Against.*** — "Under ordinary circumstances, many cases are recorded in works upon poisons, such as Dr. Christison's, where decayed animal food has produced

severe and even fatal diarrhœa, in spite of cookery having concealed some of its repulsiveness. High game has fortunately gone out of fashion, and the most frequent form in which we now meet with decomposing albuminoid matter is that of a fusty egg. Some housekeepers seem to consider this quite good enough for made dishes, and thus spoil material worth ten times what they save by their nasty economy. No egg should be allowed to enter the kitchen that has the slightest smell of rotten straw." — *Manual of Diet.* Dr. T. K. Chambers.

P. **131,** § **194** (*b.*). ***Selection of Meats.*** — "Good meat has the following characters: 1. It is neither of a pale pink color nor of a deep purple tint, for the former is a sign of disease, and the latter indicates that the animal has not been slaughtered, but has died with the blood in it, or has suffered from acute fever. 2. It has a marbled appearance from the ramifications of little veins of fat among the muscles. 3. It should be firm and elastic to the touch, and should scarcely moisten the fingers — bad meat being wet and sodden and flabby, with the fat looking like jelly or wet parchment. 4. It should have little or no odor, and the odor should not be disagreeable, for diseased meat has a sickly, cadaverous smell, and sometimes a smell of physic. This is very discoverable when the meat is chopped up and drenched with warm water. 5. It should not shrink much in cooking. 6. It should not run to water or become very wet on standing for a day or so, but should, on the contrary, dry upon the surface." — *Letheby on Food.*

P. **136,** § **204** (*a.*). ***The Importance of Vegetable Food.*** — "The commonest fault committed by housekeepers in respect of vegetables is, that they do not supply a sufficient variety, seeming to consider that the meat is the only part of the meal that requires care, and that all the rest is mere garnish; beneath the notice of a Briton, and unfit to sustain his vigorous life. Yet that is not the experience of the observers of mankind. The attention of Herodotus was called to the fact that the Persians, the manliest and most sporting nation in the world, had at meals not only several dishes, but several courses of vegetable food, preceding a very moderate allowance of solid meat. And Sir Henry Rawlinson describes the diet of this tough race as practically the same now, so that the assumptions of some anthropologists that hunting races are necessarily riotous eaters of flesh, and that carnivoracity strengthens a nation, are not accurate. The Persian gentleman is the spiritual father of the British squire; yet, at many a hospitable board, if a guest does not fancy meat that day, or has eaten enough of it at a previous meal, he will have to fall back upon potatoes, or to solace himself by picking a few bits out of the sauces of made dishes, where the vegetable flavor has been saturated with

that of meat and spoilt. Usually, he goes on eating too much nitrogenous food out of sheer idleness." — *Manual of Diet.* CHAMBERS.

P. 137, § 205 (*a.*). *Salads.* — "Vegetables intended to be used for salad should all be fresh and crisp, and sweet and clean. Their colors should be positive and even; the reds very red, the whites very white, and the greens pure as those in an autumn sunset sky, except in the full-grown leaves, such as watercress. . . . With a little trouble, not, however, necessarily attended by expense, a succession may be provided of materials for salad all the year round, so as to have one at table every day. And a great preservation of health I believe it to be for hearty persons. The most difficult season to provide for is the latter end of winter, and it may be of use to mention that the *dandelion* is then a friend in need. If a pot be placed over the plant as it grows, or the leaves tied up like lettuce, or it be transplanted into a frame, it can be bleached, and thus loses its bitterness. Daisy leaves are also eatable; and thus, with a sprig of tarragon, a few cold potatoes, and some ever-constant mustard and cress, giant cress, Australian or curled cress, an olive or two pared thin, or some beet-root and a slice of Madeira onion, a great variety of combinations may be made." — *Manual of Diet.* CHAMBERS.

P. 137, § 206 (*a.*). *The Food Value of Peas, Beans, etc.* — "Then there are the vegetable albuminoids, especially the pulse tribe, or legumes, which are capitally disintegrated by cooking, and best by boiling or baking. Thus beans, haricots and broad, peas, lentils, dahl, etc., are all well broken up by heat. The disintegrated flour can easily be passed through a sieve, and then the disintegration factor of the digestive act is disposed of. There can be no question about the fact that with some persons vegetable albuminoids are much more easily digested than animal albuminoids; and I quite agree with Sir Henry Thompson in his remarks upon this subject. Besides, too, fat spreads easily over the disintegrated particles of cooked vegetable albuminoids, as is well seen in the baked beans and fat pork of New England. Indeed, by such means, fat can often be taken without offence to a stomach that cannot otherwise tolerate it; and much of the digestibility of fat depends upon the fineness of the particles into which it is sub-divided. Haricot beans well boiled, passed through a sieve, and then the floury part mixed with milk, makes an excellent soup; quite equal in food value to any made with meat stock. The ordinary lentil soup is at once a most economical and a most valuable soup, though scarcely, perhaps, quite adapted for persons with indigestion. But 'the proof of the pudding is in the eating thereof,' — if it does not disagree, there is certainly no objection to its use." — FOTHERGILL.

P. 137, § 206 (*a.*). *Combinations of Food.* — "Certain combinations of the various foods of man are absolutely necessary for the nutrition

of his tissues, the maintenance of the body heat, and the evolution of force. Consequently, we find meat, especially lean meat, and potatoes taken together; pork and boiled peas; liver and bacon; bacon and beans; lean beef and fat bacon; bread and butter and cheese; raisins and almonds, etc. In these combinations the different forms of food are included, the one constituent supplementing what is deficient in the other. The most perfect combination, both chemically and for bulk and keeping qualities, is the sausage invented for the German army in the war with France in 1870. It consists of two concentrated forms of food, or, to speak more correctly, of food in a form to give the maximum of nutrition with the minimum of bulk, pea meal and bacon fat with condiments. It is a combination at first sight scarcely likely to form an article of common use, but it suits its purpose well, and supplied the absolutely essential material for nutrition, leaving the soldier to add bulk in any form he found agreeable and palatable." — *The Maintenance of Health.* FOTHERGILL.

P. 138, § 207 (*a*.). *The Quenching of Thirst by Fruit rather than by Liquor.* — "Some dyspeptics find that they must take no fluids with their food, and have to live on a very dry dietary, an Arab dietary. Others require more fluids than they allow themselves. Others require a biscuit, or some light article of food 'betwixt meals.' When this is made an excuse for a glass of sherry, it is to be closely criticised as a questionable habit, 'more honored in the breach than the observance.' To take some fruit would be better in every way. Some succulent fruit would satisfy the craving 'for something,' and would not require the beverage 'to get it down.' Such use of fruit ought to be more general than it is at present. In all households where the expense does not forbid it, a large dish of picked fruit of various kinds, when the season permits of it, should be placed on the side-board every morning, with a label 'Help yourself' on it (as is found in the waiting-rooms of several London consultants). Children would soon cease to overeat themselves, just as do the assistants in confectioners' shops, when they realize that it is to be a constant affair, not an occasional treat to be made the most of. Such an idea is well worthy of adoption. If the 'temperance' section of society would set the example, it would soon be followed by others, to the benefit of the digestive organs of many while it would be agreeable to all. Fresh gathered fruit out of the garden and orchard ought to be placed on the breakfast table every morning. For those who experience a bitter or hot taste in the morning on awakening, such addition to the breakfast table would be most acceptable." — *Indigestion and Biliousness.* FOTHERGILL.

P. 139, § 209 (*a*.). *Miss Corson on the Use of Savory Herbs.* — Miss Corson, Superintendent of the New York Cooking School, in her

Cooking Manual, says : "Sweet and savory herbs are absolutely indispensable to good cooking; they give variety and savory flavors to any dish into which they enter, and are nearly all of some decided sanitary use; the different kinds called for in the various receipts further on in this work can be bought at almost any grocery store, or in the market; but we advise our readers to obtain seeds from some good florist and make little kitchen gardens of their own, even if the space planted be only a box of mould in the kitchen window. Sage, thyme, summer savory, sweet marjoram, tarragon, sweet basil, rosemary, mint, burnet, chervil, dill, and parsley will grow abundantly with very little care; and when dried and added judiciously to food, greatly improve its flavor. Parsley, tarragon, and fennel should be dried in May, June, and July, just before flowering; mint in June and July; thyme, marjoram, and savory in July and August; basil and sage in August and September; all herbs should be gathered in the sunshine, and dried by artificial heat; their flavor is best preserved by keeping them in air-tight tin cans."

P. **139**, § **210** (*a*.). ***Ice and Ice Water.*** — "About three pints of fluids are the normal allowance of water to human beings in a temperate clime under ordinary circumstances; but when there is much perspiration, induced by exertion or other cause, a much larger quantity is necessary In iron works, the men, exposed to high temperatures and bathed in perspiration, when at work drink from two to four gallons of fluids per diem. There is a popular prejudice against drinking freely of cold fluids when heated, and no doubt death is sometimes so induced; but the consumption of cold and even chilled drinks is now much on the increase. Ice is no longer regarded as a mere luxury; it has become a necessary of life in hot weather, and its addition to a beverage adds much to its agreeableness. The chilled fluid directly lowers the heat of the body, and abstracts from it as much heat as is requisite to raise the temperature of the chilled fluid to that of the body, that is, from about 32° to 99°; this exercises a distinct influence over the body temperature for some time. It is obvious from this that the quantity of the chilled fluid has much to do with the effect, and a pint will take twice as much heat to raise its temperature as will half a pint. Consequently it is not unimportant to the imbiber what the amount of his fluid is, as well as its temperature; and to those who produce heat but slowly a sip of iced fluid is as cooling as a draught of it to another whose heat-forming power is great. The draught of the latter would be as dangerous to the first, as the sip of the first would be useless and ineffective to the latter. At all entertainments, dancing and other, where the heat becomes great, ice, both as a beverage and in the more solid form of ice cream, forms now the essential matter of the refreshment table, and is very acceptable. It

must be remembered, however, that free indulgence in iced fluids is very apt to induce a sharp diarrhœa in many persons. Also the free consumption of ice has not unfrequently the effect of creating even a stronger craving than ever for fluids, from the same action upon the throat that snowballs have on boys' hands — the persistent cold causes a free flow of arterial blood to the part. In such case a drink of warm fluid often gives relief." — *Maintenance of Health.* FOTHERGILL.

P. **140**, § **211** (*a.*). ***Pure Spring Water.*** — "A country house is fortunate if it possesses at a convenient distance a good, cool, copious spring. Nothing is more attractive or more serviceable about a Pennsylvania farm than the spring house; often jutting out from a bank or hillside, built low, but firmly, of gray stone, and shaded over by a few old trees. Within you see the clear, transparent pool of water, in its reservoir of stone, pure as the air or sky overhead; and around it, or carefully placed in it, the pans of milk or cream, or butter, waiting for family use. A draught from that supply, flowing out to make a limpid stream through the meadow below, gives more refreshment on a midsummer day than the most tempting beverage of man's contrivance. It has in it no horrors, no mockery, *only health.*" — *Our Homes.* HENRY HARTSHORNE, M.D.

P. **143**, § **215** (*a.*). ***When Scum and Water Weeds are Harmful.*** — "According to Prof. W. G. Farlow, M.D.,[1] the flowering plants known as water weeds, both those that grow from the bottom of ponds and water-courses, and have distinct stems and leaves, and also those that float on the surface as scum, are, under ordinary circumstances, harmless. They may prove (1) troublesome or injurious by growing so luxuriantly as to choke up small streams and shallow ponds; (2) by serving as points of attachment or shelter for injurious small plants; and (3) by decaying in hot weather."

P. **144**, § **216** (*a.*). ***Purification of Water by Filtering.*** — The following *home-made* filter is advised by Dr. Parkes, the eminent sanitarian: "Take a large, common flower-pot, and put into it a bit of zinc gauze or a clean bit of flannel; then coarse gravel to the depth of about three inches; over that the same amount of white sand washed very clean; and next, four inches of charcoal in small fragments, — animal charcoal when it can be had. On the top of all, a piece of well-cleaned sponge may be placed, making sure that this is changed or thoroughly cleansed once in a week or two; more or less often, according to the impurity of the water."

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[1] First Report of Louisiana Board of Health.

"If the water be impure, it may be rendered sweet by charcoal powder." "This is one of the greatest and most beneficial discoveries of modern times, for which we are indebted to Mr. Lowiz of Petersburgh. Water which has a disagreeable odor, or has become putrid, may almost immediately be freed from its nauseous taste, as well as its bad smell, and be converted into good drinkable liquor, by the following process: Take some burnt charcoal, and reduce it to a fine powder. Mix about a tablespoonful of this powder in a pint of water, stir it well around, and suffer it to stand for a few minutes. Let it then run slowly through filtering paper into a glass, and it will be found quite transparent, without any bad taste or smell, and perfectly pure for drinking. People may preserve the charcoal powder a long time in a small bottle well corked, and carry it with them when they travel." — *Hufeland's Art of Prolonging Life.* Note by Erasmus Wilson, M.D.

P. **147**, § **221** (*a.*). ***The Use of Alcohol as a Medicine.*** — "*Under the pressing demands* of a progressive civilization, the hurry of business, the excitements of professional life, the exhaustion of the nervous system is enormous. Every agent that offers relief is eagerly sought, and stimulants and narcotics meet the demand. For a brief period they soothe and comfort . . . but the same agents that deceive into joy leave the victim in greater depression and with more lasting fatigue. Under their influence, the intellectual faculties are quickened, but, sooner or later, by their over-stimulation, mental weakness and sometimes imbecility results. . . . The daily use of alcohol by those in *health* is needless, and often harmful. Wine is a stimulant to digestion. More food is taken than is needed for the growth of the body and the daily waste. All food taken in excess of the bodily requirements is not only useless, but positively injurious, for it becomes a burden on the organism, and leads to disease. Alcohol also interferes with the proper oxidation of the waste material by offering to the oxygen of the blood an easily burned carbo-hydrate. The alcohol is consumed while the waste material, which must be oxidized to prepare it for elimination, escapes perfect combustion, and there results accumulation of poisonous compounds in the body, causing that class of ailments known as "waste diseases." This action of alcohol, harmful in health, leads to excellent results when properly used in disease, especially those characterized by high temperature and rapid emaciation. . . . But is there not danger that the use of alcohol, in the treatment of disease, may lead to habits of intemperance? Doubtless, such cases have occurred, but we must remember that these habits are not infrequently referred to medical advice as the least unpleasant explanation of their origin. . . . But when there is the least danger, the physician should be ever on his guard. He has the right to *pro*scribe as well as *pre*scribe, and it is better that a

hundred men should be sick a few days longer than they otherwise might be than that *one* should get up a drunkard or an opium-eater."—Extract from an address delivered by PROF. J. A. MCCORKLE, on the *Use and Abuse of Narcotics and Stimulants:* Jan., 1884.

P. **147,** § **221** (*a.*). ***Moderate Drinking; its Dangers.*** — "It is a mournful spectacle — that of the brave, ingenuous, high-spirited man sinking steadily down into the degradation of inebriety; but how many such spectacles are visible all over the land! And it is not in the character of those alone who are notorious drunkards that such tendencies appear. They are often distinctly seen in the lives of men who are never drunk. Sir Henry Thompson's testimony is emphatic to the effect that 'the habitual use of fermented liquors, to an extent far short of what is necessary to produce intoxication, injures the body and diminishes the mental power.' If, as he testifies, a large proportion of the most painful and dangerous maladies of the body are due to 'the use of fermented liquors, taken in the quantity which is conventionally deemed moderate,' then it is certain that such use of them must result also in serious injuries to the mental and moral nature. Who does not know reputable gentlemen, physicians, artists, clergymen even, who were never drunk in their lives, and never will be, but who reveal, in conversation and in conduct, certain melancholy effects of the drinking habit? The brain is so often inflamed with alcohol that its functions are imperfectly performed, and there is a perceptible loss of mental power and of moral tone. The drinker is not conscious of this loss; but those who know him best are painfully aware that his perceptions are less keen, his judgments less sound, his temper less serene, his spiritual vision less clear, because he tarries every day a little too long at the wine. Even those who refuse to entertain ascetic theories respecting these beverages may be able to see that there are uses of them that stop short of drunkenness, and that are still extremely hurtful to the mind and the heart as well as the body. That conventional idea of moderation, to which Sir Henry Thompson refers, is quite elastic; the term is stretched to cover habits that are steadily despoiling the life of its rarest fruits. The drinking habit is often defended by reputable gentlemen to whom the very thought of a debauch would be shocking, but to whom, if it were only lawful, in the tender and just solicitude of friendship, such words as these might be spoken: 'It is true that you are not drunkards, and may never be; but if you could know, what is too evident to those who love you best, how your character is slowly losing the firmness of its texture and the fineness of its outline; how your art deteriorates in the delicacy of its touch; how the atmosphere of your life seems to grow murky and the sky lowers gloomily above you, — you would not think your daily indulgence harmless in its measure. It is in just such

lives as yours that drink exhibits some of its most mournful tragedies.'" — *The Century.*

P. **148,** § **222** (*a.*). ***Alcohol of little Value in Maintaining Animal Heat.*** — " . . . My first illustration was obtained through Sir John Richardson, a medical officer high in our naval service, who was early associated with Sir John Franklin in Arctic exploration. It was then his conclusion that, even under extreme privation, the use of alcoholics did much more harm than good; so that it was better to burn the alcohol in a lamp, and to heat tea or some other liquid with it, and by drinking this to get a real heating effect, than to put the alcohol into the stomach. For what heat they got from one was so much gain; while the other, being only a stimulant, was followed by a depression which made the cold seem only more severe. On another expedition (the first sent to look for Franklin), Sir John Richardson passed the winter with a party in the north of America, as near the borders of the Icy Sea as they could reach. They were well supplied with food, and lived in a log-house which had been built for them by our Hudson's Bay Company. Sir John had made it a strict condition that his party should go out upon strictly total abstinence principles; he would not have any spirit at all. It was a part of his work through the winter to make a series of magnetic observations; and it was necessary that the magnetic observatory should be at a short distance from the house, in order to avoid the local attraction of iron. Sir John told me that he was accustomed to go out at night from the house to the magnetic observatory — as it were, to go across the street, where he would make his observations, and return — without even putting on his great-coat. I asked him how cold was the temperature to which he exposed himself. He said that the temperature in the log-house was about fifty degrees above zero, and that outside it would sometimes be about fifty below zero. There was a change of *a hundred degrees,* which he found he was able to endure for a quarter of an hour without putting on his great-coat. That will show the kind of evidence which I proceeded upon. Many of our Arctic voyagers have given me the same experience. Sir Joseph Hooker, who served with Captain James Ross in his Antarctic expedition about forty years ago, has given me evidence of nearly the same kind. And we have now the scientific *rationale* of these facts, in the proof obtained by chemical means, that the alcohol taken into the body is not burned at all, but is expelled from it as a substance foreign to its constitution." — *The Physiology of Alcoholics,* by Wm. B. Carpenter, M.D., L.L.D., F.R.S.

P. **149,** § **223** (*a.*). ***Cigarette Smoking.*** — "Scarcely less injurious, in a subtle and generally unrecognized way, than the habit of taking 'nips' of alcohol between meals, is the growing practice of smoking cigarettes incessantly. We have not a word to say against smoking at

suitable times and in moderation, nor do our remarks at this moment apply to the use of cigars or pipes. It is against the habit of smoking cigarettes in large quantities, with the belief that these miniature doses of nicotine are innocuous, we desire to enter a protest. The truth is that, perhaps owing to the way the tobacco leaf is shredded, coupled with the fact that it is brought into more direct relation with the mouth and air passages than when it is smoked in a pipe or cigar, the effects produced on the nervous system by a free consumption of cigarettes are more marked and characteristic than those recognizable after recourse to other modes of smoking. A pulse-tracing, made after the subject has smoked a dozen cigarettes, will, as a rule, be flatter and more indicative of depression than one taken after the smoking of cigars. It is no uncommon practice for young men who smoke cigarettes habitually to consume from eight to twelve in an hour, and to keep this up for four or five hours daily. The total quantity of tobacco used may not seem large, but, beyond question, the volume of smoke to which the breath organs of the smoker are exposed, and the characteristics of that smoke as regards the proportion of nicotine introduced into the system, combine to place the organism very fully under the influence of the tobacco. A considerable number of cases have been brought under our notice during the last few months, in which youths and young men who have not yet completed the full term of physical development have had their health seriously impaired by the practice of almost incessantly smoking cigarettes. It is well that the facts should be known, as the impression evidently prevails that any number of these little 'whiffs' must needs be perfectly innocuous, whereas they often do infinite harm." — *Lancet.*

P. **194**, § **269** (*a.*). *The Results of re-breathing Expired Air.* — "If you want to see how different the breath breathed out is from the breath taken in, you have only to try a somewhat cruel experiment, but one which people too often try upon themselves, their children, and their work-people. If you take any small animal with lungs like your own, — a mouse, for instance, — and force it to breathe no air but what you have breathed already; if you put it in a close box, and, while you take in breath from the outer air, send out your breath through a tube into that box, the animal will soon faint; if you go on long with this process, it will die.

"Take a second instance, which I beg to press most seriously on the notice of mothers, governesses, and nurses. If you allow a child to get into the habit of sleeping with its head under the bed-clothes, and thereby breathing its own breath over and over again, that child will, assuredly, grow pale, weak, and ill. Medical men have cases on record of scrofula appearing in children previously healthy, which could only be accounted

for from this habit, and which ceased when the habit stopped." — *Health and Education.* Rev. CHAS. KINGSLEY.

P. **198,** § **274** (*a.*). ***The Adoption of Prevalent Customs.*** — The emigrant "should always adopt any custom which, however new and strange, he finds in use among the settlers of a new country. Those who have preceded him have had the like Saxon unwillingness to adopt a new habit, and have only done so from necessity, the reasons for which may not always be apparent. It is better to fall into it at once, and then seek for its explanation. Especially is this caution necessary in the matter of food. Thus the newly-arrived emigrant in India goes on with his English food, his bottled beer, wine, etc., and is ere long a broken-down, jaundiced creature, whose liver has been ruined, firstly, by the work thrown upon it in accumulation of bile in it in excess, the climate only requiring sparing quantities of food, and, secondly, by the medicine taken to relieve his condition. . . . In travelling, the same thing is seen, though to a less extent than in emigration, and the superior power of adaptation to the wants and requirements of the country explains the health of one person, and the want of it, much of the ill-health of another." — *Maintenance of Health.* FOTHERGILL.

P. **204,** § **283** (*a.*). ***To what Contagious and Infectious Diseases are Due.*** — These germs are believed to belong to the fungi, and are known as *bacteria.* They differ in form and mode of development, depending upon the diseased condition with which they are associated. Some of the diseases which depend to a greater or less extent upon these germs, and hence are known as infectious or contagious diseases, are anthrax, diphtheria, leprosy, scarlet and typhus fevers, etc. It is worthy of note that recent investigations seem to prove that consumption and cholera have their infecting germs, which may induce in a person ready for their development these serious diseases.

"The presence of septic organisms, possessing different degrees of virulence depending upon the abundance and kind of pabulum furnished them, and upon meteorological conditions more or less favorable, constitutes, in my opinion, the *epidemic constitution of the atmosphere,* which wise men were wont to speak of, not many years ago, as a cloak for ignorance. It must be remembered that the gutter mud of to-day, with its deadly septic organisms, is the dust of to-morrow, which, in respiration, is deposited upon the mucous membrane of the respiratory passages of those who breathe the air loaded with it. Whether the peculiar poison of each specific disease is of the same nature or not, — a question which can only be settled by extending experimental investigations in the future, — it is altogether probable that this factor often gives a malignant character

to epidemics of diseases which, uncomplicated, are of a comparatively trivial nature." — *Bulletin of National Board of Health.* Dr. Geo. M. Sternberg, U.S.A.

P. **204,** § **283** (*b.*). ***The Germ Theory of Disease.*** — "During the last few years, the germ theory of disease has rapidly been gaining ground. It is now, indeed, all but universally admitted that many of the diseases called zymotic, which comprises epidemic, endemic, and contagious diseases, owe their origin to germs introduced into the organization from without. For these germs, however, to take root as it were, to develop, the animal organization must be prepared for their reception. The most efficacious preparation, no doubt, is a low state of vitality from defective nutrition. We are, throughout life, constantly receiving into the economy these germs of disease; but, if the nutritive functions are sound, and the organization is healthy, it resists their presence and action. They do not find in it a suitable nidus wherein to germinate, so they are destroyed or expelled. Following this train of thought, we arrive at the inevitable conclusion that to escape the attack of zymotic disease we must be in good health, that is, in a sound nutritive state." — Bennett, *Nutrition in Health and Disease.*

P. **206,** § **284** (*a.*). ***The "Black Hole of Calcutta."*** — In 1756, one hundred and forty-six English prisoners in Calcutta were confined over night in an apartment about eighteen feet square and fourteen feet high, having but one small window. In the morning, there were alive *twenty-three* only of the strongest, who had been able to get near the window in the struggle that had occurred for fresh air. And of these, nearly all died subsequently of a very low type of typhus fever, known as "putrid fever." The place of their imprisonment has ever since been known as the "Black Hole of Calcutta."

Of the one hundred and fifty passengers shut up in the steamer *Londonderry,* with hatches battened down, during a stormy night in 1848, seventy-two died before morning.

P. **206,** § **284** (*b.*). ***The Air of Bedrooms, Hospital Wards, etc.*** — The air escaping from the ventilator of a crowded room is said to be very offensive, and, if drawn through pure water, will taint it. The air of bedrooms sometimes becomes so contaminated at night that sleep is restless or broken. The admission of a little fresh air will at such times often enable one to sleep soundly. Little children, or feeble persons, having passed the night in a close room, are liable in the morning to headache, want of appetite, and a general feeling of debility.

At times, the walls, floors, and bedding of hospital wards become so permeated with poisonous organic matter that to stay in them is unsafe

until a thorough cleansing and disinfection has taken place, the walls sometimes even requiring to be entirely replastered.

P. 206, § 285 (*a*.). ***The Value of the Eucalyptus Tree.*** — "That the *E. globulus* has earned by fair experiment its name of fever-tree, as a preventive, seems now to be settled. Its rapid growth must make it a great drainer of wet soils, while its marked terebinthine odor may have its influence, and it is highly probable that the liberation of this essence into the air stands connected with its generation of ozone. But whatever the sanatory activities of the eucalypt may be, the fact is squarely settled that spots in Italy, uninhabitable because of malarial fever, have been rendered tolerable by the planting of *E. globulus*, and it is believed that a more plentiful planting would nearly, if not quite, remove the difficulty. A military post is mentioned in Algeria in which the garrison had to be changed every five days, such was the virulence of the malaria. A plantation of eucalypts cleared the miasma nearly away, and rendered unnecessary the frequent changes of the garrison. In this case, sixty thousand trees were planted." — *Popular Science Monthly:* April, 1876. Prof. Samuel Lockwood.

P. 206, § 285 (*a*.). ***Some Facts about Malaria.*** — The term *malaria*, at the present time (1884), is frequently applied to a number of abnormal conditions of health, instead of being used to express a cause of disease, as the word from its derivation implies. The reason for its present use seems to be that the changes in the way of warming and ventilating houses, change in industries, in the style of living, in the habits as to hours, etc., which have occurred within the last twenty years, have given rise to that peculiar cachexia, which is now called "malaria," which resembles that caused by the "fever and ague" poison. As to the latter, it is of interest to state the experience of Dr. A. N. Bell, the eminent sanitarian, who says "that this poison is a poor sailor, seldom crossing large bodies of water, and is most potent at night. So well do the natives of hot and malarious countries understand this, that at Lake Maracaibo, for example, they sleep at night in their boats on the lake, after their labor through the day on shore, not allowing themselves to stay on the deadly poisonous shore after sunset, or to return to it until after sunrise."

P. 208, § 287 (*a*.). ***Carbonic Acid in Caves, Wells, etc.*** — "Upon the borders of Lake Laacher, near the Rhine, and in Aigueperse, in Auvergne, there are two sources of carbonic acid so abundant that they give rise to accidents in the open country. The gas rises out of small hollows in the ground, where the vegetation is very rich; the insects and small animals, attracted by the richness of the verdure, seek shelter there,

and are at once asphyxiated. Their bodies attract the birds, which also perish. In former times the accidents caused by this gas in caves, mines, and even in wells, gave rise to the most extravagant stories. Such localities were said to be haunted by demons, gnomes, or genii, the guardians of subterranean treasures, whose glance alone caused death, as no trace of lesion or bruise was to be found on the unfortunate persons so suddenly struck down." — *The Atmosphere.* CAMMILE FLAMMARION.

P. 208, § 288 (*a.*). ***Carbonic Acid in Dwellings, Schools, etc.*** — "The air in a

London school-room	contained	29	parts	of	carbonic	acid	in	10,000	of	air,
Munich "	"	72	"	"	"	"	"	"	"	"
Hospital at Madrid	"	43	"	"	"	"	"	"	"	"
Bedroom " "	"	48	"	"	"	"	"	"	"	"
Lecture room at Paris	"	67	"	"	"	"	"	"	"	" "

Our Homes (Health Primer). HENRY HARTSHORNE, A.M., M.D.

A similar excess often exists in our schools, lecture rooms, etc., causing the inmates to be listless and drowsy, and to suffer from headache and faintness. According to Pettenkofer, a man exhales every hour from six to seven-tenths of a cubic foot of carbonic acid gas. Angus Smith asserts that a good oil "moderator" lamp produces a little more than half a cubic foot. A common gas burner, consuming three cubic feet of gas per hour, gives off about as much carbonic acid as three men in the same time would do. . . . The light from a good and properly cared for student's lamp, or other reliable lamp, is much better for health as well as eyesight than illuminating gas; but if the oil is poor, or the wick is turned so low that combustion is imperfect, a poisonous vapor mixed with floating specks of carbon diffuses itself through the air, and instances are on record of severe prostration resulting from such impurities.

P. 208, § 288 (*a.*). ***A Simple Test for Carbonic Acid.*** — Dr. Angus Smith's *Household Test for Carbonic Acid* is as follows: "Procure a bottle holding ten and a half fluid ounces, fill it with the air of the room you wish to examine, by blowing it in with a bellows or sucking it in through a glass tube pushed down to the bottom of the vial; pour in half an ounce of lime-water, and after corking tightly, shake well for two or three minutes. If, after a short time, there is no milky appearance of the lime-water, you may know to a certainty that the ten ounces of air in the bottle do not contain enough carbonic acid to form a visible precipitate of carbonate of lime (chalk) in the lime-water, and this has been proved by careful experiment on a large scale to be equal to less than six-hundredths of one per cent of carbonic acid in the sample of air tested; a quantity which has been agreed upon by some high sanitary authorities as the limit

beyond which the accumulation of this impurity (and others, perhaps much more noxious, which seem always to accompany it when it arises from human or animal respiration) is injurious to health, and should not be permitted to occur." — *Long Life and How to Reach It.* A Health Primer, by J. G. Richardson, M.D.

P. **211,** § **294** (*a.*). ***Poisonous Wall Papers.*** — Within the last few years it has been demonstrated by physicians and chemists, both in this country and Europe, that wall papers (especially those that are roughened or "flocked" and of a bright green color) are at times poisonous, owing to arsenical substances in the coloring. The arsenic acts as a poison by being diffused in the dust of the rooms, or, as some believe, in a gaseous form as arsenuretted hydrogen, when it may be recognized by a "garlic-like or musty odor." The phenomena of arsenical disease ordinarily produced are similar to those attending a severe cold, viz., an irritation of the eyes and the lining membrane of the nose and throat. The irritation may extend to the bronchial tubes, lungs, and lower portions of the alimentary canal, or the poison may produce skin eruptions, or be absorbed in such quantity as to produce convulsions and various disturbances of the nervous system. For further information in regard to poisonous wall papers, the reader is referred to the investigations made by Dr. Kedzie, as detailed in the *Reports of the Michigan State Board of Health.*

P. **211,** § **294** (*a.*). ***Devitalized Air in Dwellings.*** — "In many private houses, houses even of the well-to-do and wealthy, streams of devitalized air are nursed with the utmost care. There is the lumber-room of the house, in which all kinds of incongruous things are huddled away and excluded from light and fresh air. There are dark under-stair closets in which cast-off clothes, charged with organic *débris* of the body, are let rest for days or even weeks together. There are bedrooms overstocked with furniture, the floors covered with heavy carpets in which are collected pounds upon pounds of organic dust. There are dressing-rooms in which are stowed away old shoes and well-packed drawers of well-worn clothing. There are dining-rooms in which the odor of the latest meal is never absent, and from the sideboard and cupboards of which the smell of decomposing fruit or cheese is always emanating, etc., etc. . . . Under such conditions thousands of families live, children grow up, and old people die. They may all go for years and suffer no acute disease, and those of the family whose duty calls them daily into the open air may even be healthy; but those who have to remain nearly all day in the devitalized atmosphere of the home, show the fact in paleness of face, languor of limb, persistent sense of weariness and dullness of spirit. Under such conditions acute disease, epidemic fever, or

other actively dangerous malady need not occur unless it be introduced from without; but the home is ready for it if it be introduced." — *Diseases of Modern Life.* Benjamin Ward Richardson, M.D., M.A., F.R.S., Eng.

P. **211,** § **294** (*b.*). ***Cleanliness versus Dirt.*** — "True cleanliness is a matter of minutiæ, and admits of no subterfuge. If dirt can find a crack, a ledge, or an absorbent surface which cannot be reached by the ordinary method of cleansing, there dirt will accumulate; and where dirt is, there will disease be also. If we are to look to our neighbors for painstaking cleanliness, we must go to Holland for example, where it is popularly believed that no gastronomic injury would ensue from dining directly off the flooring-boards or tiles. Beyond the delightful duty of scrubbing everything which is not painted, the Dutchman and his wife find no such esoteric and sanitary delight as in painting everything which cannot be scrubbed or rubbed bright. And the Dutchman is right. No layer upon layer of paper hangings, with brown, gray, or green arsenical dust to slowly poison the more susceptible of the family. No sham plaster walls, porous to sewer-gas and corrupted with putrefied paste, can be allowed. If we have lath and plaster, let it be painted; and if we cannot have wainscot or mahogany kept brilliant by continual cleanly friction and polish, let us have a clean, painted, wooden surface, as artistic in tint and in the disposal of the colors and decoration as taste and means will afford it; but to carry out a determined war against dirt and disease, let us have paint. These are no longer notions peculiar to the Dutch. They are sanitary axioms which we cannot afford to ignore." — Paper on *Chemistry of Dirt.* H. C. Bartlett, Ph.D., F.C.S., England.

P. **212,** § **295** (*a.*). ***Dr. Richardson on Damp Air in Houses.*** — "It is not invariably the new house that is rendered dangerous by being damp. There are in this country many old houses, picturesquely situated, which are not less dangerous. The stranger passing one of these residences is struck by its beauty. There is the ancient moat around it, or the lake in front with the sailing-boat and swans, the summer-house and splendid trees down to the water's edge. The stranger may well enough be fascinated by the view, but let him inquire and he will too often find a truly ghostly history of the place. He will be told, probably with some exaggeration of the truth, that the house is unlucky, that no one who has lived in it has reared a healthy child, and that a traditional malediction taints the place. If he enter the house, he finds a basement steaming with water vapor; walls constantly bedewed with moisture; cellars coated with fungus and mould; drawing-rooms and dining-rooms always, except in the very heat of summer, oppressive from moisture; bed-rooms, the windows of which are, in winter, often so frosted on their inner surface, from condensation of the water in the air of the room, that all day they are coated

with ice. The malediction on the young nurtured in that mansion may not be so deep as is rumored, and it is much less obscure than is imagined; but it is there, and its name is 'damp.'" — *Diseases of Modern Life.* Dr. Benjamin W. Richardson.

P. **213,** § **296** (*a.*). ***The Need of Model Tenements.*** — "The persistence of sickness and mortality in the old crowded tenement dwellings of our city, and the rapid and very great falling off in the rates of sickness and death in the new and airy sanitary dwellings like Sir Sydney Waterlow's in London, and Mr. White's in Brooklyn, or like the improved districts in Edinburgh and Glasgow, show that a great work for the physical and moral improvement of the common classes, and for the prevention of poverty and causes of pauperism, must be undertaken in plans for dwelling reform in our crowded city. The homes of the New York City poor must be provided with sunlight, fresh air, and the moral safeguards of real domesticity. The Improved Industrial Dwellings Company, of which Sir Sydney Waterlow is President, in London, report that in their nearly 3,000 tenements there are no fevers and deaths by contagious diseases, and in Glasgow the health officer reports that in the reformed dwellings he has not heard of a case of infectious disease. Let the deadly contagion of vices and crimes be exterminated from the habitations of the poor, and let the natural agencies of health and purity surround and fill their dwellings, as means of saving from pauperizing, sickness, and from the evils that medical charities and penal institutions cannot cure."

P. **214,** § **297** (*a.*). ***Out-door Air for Invalids.*** — For many years, consumption was considered only as an hereditary disease, now it is also known to be one of the results of bad air, poor food, damp dwellings, etc., and is most common among those who live in basements, cellars, and overcrowded quarters. A certain proportion of persons so afflicted can be cured, *by living in a pure, dry atmosphere, by good nourishment, suitable exercise, warmth, and agreeable surroundings.* The climate should be such that the sick may actually *live* a large part of the time in the *open air.* The importance of an abundance of fresh air will be appreciated when we consider that wild animals kept in confinement often die from diseases due to confined air or an insufficient amount of air. Monkeys are especially liable to die from consumption. On the other hand, persons quite frequently recover from very severe diseases, when the sick rooms are well aired, and nothing will injure the average patient so much as to shut the doors and windows, stop up all cracks, and then raise the temperature of the air in the room in the fear that cold will be caught. An abundance of pure air properly supplied is of especial importance in the prevention and treatment of consumption, whether we consider it as

an hereditary disease, the result of bad hygienic conditions, or as a parasitic disease, as claimed by Dr. Robert Koch of Berlin. This gentleman, after a series of experiments upon the lower animals, believes that the contagious element is a peculiar parasite or disease germ which is cast off from the lungs in the act of coughing. Hereditary tendencies, bad sanitary surroundings, and living in an atmosphere poisoned in part by the breath of consumptives, all tend to induce lung disease, and for all of them pure air is a necessity.

P. **214,** § **298** (*a.*). ***Night Air.*** — "Beware of the night wind; be sure and close your windows after dark. In other words, beware of God's free air; be sure and infect your lungs with the stagnant, azotized, and offensive atmosphere of your bedroom. In other words, beware of the rock spring; stick to sewerage. Is night air injurious? Is there a single pretext for such an idea? Since the day of creation that air has been breathed with impunity by millions of different animals, tender, delicate creatures, some of them fawns, lambs, and young birds. Thousand of soldiers, hunters, and lumbermen sleep every night in tents and open sheds without the least injurious consequences. Men in the last stage of consumption have recovered by adopting a semi-savage mode of life, and camping out-doors in all but the stormiest nights." — Dr. F. L. Oswald. *Popular Science Monthly:* March, 1881.

P. **216,** § **301** (*a.*). ***The Passage of Air through Plaster, Bricks, etc.*** — "My illustrious preceptor, Prof. John W. Draper, demonstrated, many years since, by a series of ingenious experiments, the facility with which gases diffuse, even when opposed by a pressure equivalent to that of twenty atmospheres. The illustrations exhibited this evening warrant us in the deduction that the purity of the air in our buildings, whether private or public, is due not only to ventilation and to the imperfect work of the carpenter, but also to the porosity of the plaster, and the brick or stone walls through which *diffusion* takes place, a part of the foul air within being exchanged for the fresh, oxygen-abounding air from without." — R. Ogden Doremus, M.D., LL.D.

P. **217,** § **302** (*a.*). ***Automatic Ventilation.*** — As instances of automatic ventilation, may be mentioned that plan in use in the cabins of the ferry-boats plying between New York and Brooklyn. These boats carry thousands of persons every week. Before the introduction of the automatic ventilators, the air of the cabins, at times of day when the passengers were most numerous, was stifling and impure. Since their use, a very perceptible change for the better has been noticed. The following are sometimes the results of non-automatic ventilation: In an institution for children the ventilators were open upon the doctor's visit,

but a few moments after were found filled with old clothes. In a large school, where the air was impure and the cause of sickness, an investigation showed that the ventilating apparatus, though in itself good, was of no real value, for the janitor used the fresh-air flue of the furnace as a chicken-coop, and the janitor's boy the ventilator in the roof as a pigeon-house.

P. 218, § 305 (*a*.). ***The Amount of Air needed for Ventilation.*** — "It is found by experience that when the room contains two hundred and fifty cubic feet per scholar, it is spacious enough to allow of the rapid diffusion of air without the production of perceptible currents. This may be stated in a form easier for use, viz.: The floor ought to contain twenty square feet for each scholar, and the ceiling ought to be twelve and a half or thirteen feet high. Probably this is more than is absolutely required by the youngest children." — *Sanitary Requirements in School Architecture.* Dr. D. F. Lincoln, Boston.

"The only safe principle in dealing with the subject is to have a large margin for contingencies; and the question really is not whether 600 cubic feet per man be too much, but whether 600 cubic feet per man be enough for all the purposes of warming, ventilation, and comfort. It has been said that the question of cubic space is simply a question of ventilation, but it is rather a question as to the possibility of ventilation. The more beds or encumbrances you have in a room with a limited cubic space, the more obstruction you have to ventilation. The fewer the beds, the more easy it is to ventilate the rooms. There are fewer nooks and corners, fewer surfaces opposed to the movement of the air, and less stagnation." — *Report of Barracks Improvement Commission.*

P. 219, § 308 (*a*.). — "***Instructions for Disinfection*** (*prepared for the National Board of Health*). — Disinfection is the destruction of the poisons of infectious and contagious diseases. Deodorizers, or substances which destroy smells, are not necessarily disinfectants, and disinfectants do not necessarily have an odor. Disinfection cannot compensate for want of cleanliness, nor of ventilation.

"I. Disinfectants to be Employed. — (1) Roll sulphur (brimstone) for fumigation. (2) Sulphate of iron (copperas) dissolved in water in the proportion of one and a half pounds to the gallon: for soil, sewers, etc. (3) Sulphate of zinc and common salt, dissolved together in water in the proportions of four ounces sulphate and two ounces salt to the gallon: for clothing, bed-linen, etc.

"Note. — Carbolic acid is not included in the above list for the following reasons: it is very difficult to determine the quality of the commercial article, and the purchaser can never be certain of securing it of proper strength; it is expensive, when of good quality,

and experience has shown that it must be employed in comparatively large quantities to be of any use; it is liable by its strong odor to give a false sense of security.

"II. How to Use Disinfectants. — (1) *In the Sick-room.* — The most available agents are fresh air and cleanliness. The clothing, towels, bed-linen, etc., should, on removal from the patient, and before they are taken from the room, be placed in a pail or tub of the zinc solution, boiling hot, if possible. All discharges should either be received in vessels containing copperas solution, or, when this is impracticable, should be immediately covered with copperas solution. All vessels used about the patient should be cleansed with the same solution. Unnecessary furniture, especially that which is stuffed, carpets and hangings, should, when possible, be removed from the room at the outset; otherwise they should remain for subsequent fumigation and treatment. (2) *Fumigation* with sulphur is the only practicable method for disinfecting the house. For this purpose the rooms to be disinfected must be vacated. Heavy clothing, blankets, bedding, and other articles which cannot be treated with zinc solution, should be opened and exposed during fumigation, as directed below. Close the rooms as tightly as possible, place the sulphur in iron pans supported upon bricks placed in wash-tubs containing a little water, set it on fire by hot coals or with the aid of a spoonful of alcohol, and allow the room to remain closed for twenty-four hours. For a room about ten feet square, at least two pounds of sulphur should be used; for larger rooms, proportionally increased quantities. (3) *Premises.* — Cellars, yards, stables, gutters, privies, cesspools, water-closets, drains, sewers, etc., should be frequently and liberally treated with copperas solution. The copperas solution is easily prepared by hanging a basket containing about sixty pounds of copperas in a barrel of water. (4) *Body and Bed-clothing, etc.* — It is *best* to burn all articles which have been in contact with persons sick with contagious or infectious diseases. Articles too valuable to be destroyed should be treated as follows: (*a*) Cotton, linen, flannels, blankets, etc., should be treated with the boiling-hot zinc solution; introduce piece by piece, secure thorough wetting, and boil for at least half an hour. (*b*) Heavy woollen clothing, silks, furs, stuffed bed-covers, beds, and other articles which cannot be treated with the zinc solution, should be hung in the room during fumigation, their surfaces thoroughly exposed, and pockets turned inside out. Afterward they should be hung in the open air, beaten and shaken. Pillows, beds, stuffed mattresses, upholstered furniture, etc., should be cut open, the contents spread out, and thoroughly fumigated. Carpets are best fumigated on the floor, but should afterward be removed to the open air and thoroughly beaten. (5) *Corpses* should be thoroughly washed with a zinc solution of double strength; should then be wrapped in a sheet wet with the zinc solution, and buried at once. Metallic, metal-lined, or air-tight coffins should be

used when possible; certainly when the body is to be transported for any considerable distance.

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P. **219,** § **309** (*a.*). ***Light as a Stimulus to Respiration.*** — "It has been an axiom from time immemorial that, for health, sleep should be taken during the still hours of night, and not during the day. The example of the ruddy, healthy peasant, who retires to rest with his cattle, and is up with the lark, has been quoted a thousand times. It appears to me, however, that the undeniable fact of exposure to the light of day being an element of health which vivifies and reddens the blood, was never satisfactorily explained until the publication of the experiments of the late Dr. Edward Smith, of the Brompton Hospital. Dr. Smith has proved that light is a powerful stimulus to respiration; that under the influence of daylight one-third more atmospheric air enters the lungs than under darkness, or even under exposure to artificial light. In other words, if, in daylight, during a given time, six hundred cubic inches of atmospheric air were inspired, during the same time at night only four hundred would enter the lungs; a powerful additional reason and argument for pure air at night during sleep. As the oxygenation and subsequent reddening of the blood depend on its contact with atmospheric air in the lungs during respiration, it is clear, if we accept the above statements, that the more the body is exposed to sunlight, the more oxygen it will imbibe. As a necessary sequel, the more oxygen physiologically enters the economy, through the functions of respiration, the more perfectly will all the vital processes which require oxygen be performed." — *Nutrition in Health and Disease.* Bennett.

P. **227,** § **316** (*a.*). ***Nerve Cells.*** — "The cell of the nervous tissue, like that of all other tissues, is the essential, living part. In it go on the mysterious molecular changes, which are presented to us as nervous action. To it the surrounding structures are entirely subservient. It is the textural Rome to which all roads turn. It is upheld by the connective tissue; it is nourished by the capillaries and lymphatics; it is drained by the venules. Although it differs from other cells in many ways that are strongly marked, in none is it more distinctive than in the fact that it is placed in direct, or almost direct, communication with dis-

tant structures by fibres that conduct sensations *to* it and by others that convey actions *from* it. The type of a nervous organism, then, is a cell, to which are attached conducting fibres for sensation and motion respectively. The cells being clustered together in what is known as gray matter, and the conducting fibres being composed of so-called white matter, all nervous structures are made up of gray or cellular and white or conducting matter, be the relative proportions of each, and the form of the particular organ, what they may. Each group of cells — perhaps the science of the future will enable us to say each cell — has an intelligence of its own, which has long been beclouded by the name of 'function.' This intelligence, misnamed function, is adequate to the purpose of that particular group of cells. If they be the cells of a jelly-fish, they enable the animal to float on the surface of the water, to nourish itself, and to seize its prey. If they be the cells of a bee, they enable it to organize all the wondrous economy of the hive, — to select its queen, to eliminate the drones, to build the mathematical cell. If they be the cells of the lion, they form the anatomical substratum of all the beast's kingly and ferocious habits. Finally, when they become the cells of the human gray matter, they are intelligent still, varying in the degree of that intelligence as it mounts from the lowly lower end of the spinal cord, increasing in complexity as it ascends, until it culminates in the most wonderful gray matter of all species, — the cortex of the cerebrum, the seat of the mind.

"From the foregoing statements it follows that all nervous organisms are composed of numerous foci of cellular intelligence, intercommunicating and bound together into one harmonious whole by the white or conducting fibres." — In the *Annals of the Anatomical and Surgical Society.* Dr. Landon Carter Gray.

P. **229,** § **319** (*a.*). ***The Weight of the Brain.*** — "The average male brain (in Europeans) is 49.5 oz.; the female, 44 oz. The brain of Cuvier, the naturalist, weighed 64.5 oz., and that of Daniel Webster 53.5 oz. The brains of idiots have been found to vary in weight from 27 oz. to as low as 8.5 oz. The brains of the insane are said to be $2\frac{1}{2}$ per cent. below the average of the sane. Tall men, as a rule, have larger brains than small men. . . . The maximum size of the brain is reached, not in human beings, but in the elephant tribe; and after, the whales, whose ponderous bodies demand an enormous muscular expenditure. The elephant's brain weighs from 8 to 10 lbs.; the whale's brain is said to weigh from 5 to 8 lbs. . . . In addition to the propulsion of the muscles, a considerable amount of nerve force must be expended in supporting or aiding the processes of organic life, — digestion, respiration, circulation, and other operations." — *Mind and Body.* Bain.

P. **232,** § **324** (*a.*). ***Dr. Jacobi on the Development of the Brain in Children.*** — "Between the fifth and sixth years the base of the brain grows very rapidly; the frontal bone protrudes anteriorly and grows upward. The anterior portion grows considerably, but still the white substance and middle portion of brain are prevalent. These are the organs for the receptive faculties and memory. About this time learning ought to commence in earnest. All the above figures point to the end of the seventh year as the period of beginning mental work. But the gray substance is also developing at that period. It ought to be influenced to a certain degree, like a young tree in the time of its growth, without, however, being strained. Many organs in the brain, — many functions. Neglect none; exercise all gently. It is a mistake to exercise one faculty only. Our text-books, in the shape of catechisms, exercise the memory only, and thereby fatigue and exhaust. The compound exercise consisting in walking, with its changes and coöperative action, is less fatiguing than standing on a single leg. Learning by heart is not learning, and reciting is not thinking; just as little as deglutition is digestion." — *Trans. N. Y. Academy of Medicine.* A. Jacobi, M.D.

P. **253,** § **349** (*a.*). ***How the Nervous System is Injured by Overwork.*** — "You see, my dear working friends, I am great upon sparing your strength and taking things cannily. 'All very well,' say you, 'it is easy speaking, and saying "Take it easy"; but if the pot's on the fire, it maun bile.' It must: but you needn't poke up the fire forever, and you may now and then set the kettle on the hob and let it sing, instead of leaving it to burn its bottom out. I had a friend who injured himself by overwork. One day I asked the servant if any person had called, and was told that someone had 'Who was it?' 'Oh, it's the little gentleman that *aye rins when he walks!*' So I wish this age would walk more, and 'rin' less. A man can walk farther and longer than he can run, and it is poor saving to get out of breath. . . . I am constantly seeing men who suffer, and indeed die, from living too fast; from true, though not consciously immoral, dissipation or scattering of their lives. Many a man is bankrupt in constitution at forty-five, and either takes out a *cessio* of himself to the grave, or goes on paying ten per cent for his stock-in-trade: he spends his capital instead of merely spending what he makes, or, better still, laying up a purse for the days of darkness and old age. A queer man, forty years ago, Mr. Slate, or, as he was called, *Schlate,* — who was too clever and not clever enough, and had not wisdom to use his wit, always scheming, full of 'go' but never getting on, — was stopped by his friend, Sir Walter Scott (that wonderful friend of us all, to whom we owe Jeannie Deans and Rob Roy, Meg Merriles, and Dandie Dinmont, Jinglin' Geordie, Cuddie Headrigg, and the immortal Bailie), one day, in Princess Street

'How are ye getting on, Schlate?' 'Oo, just the auld thing, Sir Walter; *ma pennies a' gang on tippenny eerands.*' And so it is with our nervous power, with our vital capital, with the pence of life, — many of them go on 'tippenny eerands.' We are forever getting our bills renewed, till down comes the poor and damaged concern with dropsy or consumption, blazing-fever madness or palsy." — *Spare Hours.* Dr. John Brown.

P. **254,** § **350** (*a.*). ***Wear and Tear of the Body.*** — "Again let me impress this truth upon you, that it is not pure brain work but brain excitement or brain distress, that eventuates in brain degeneration and disease. Calm, vigorous, severe mental labor may be far pursued without risk or detriment; but whenever an element of feverish anxiety, wearing responsibility, or vexing chagrin is introduced, then come danger and damage." — *Dr. Crichton Browne,* of the Wakefield Asylum.

"I have called these hints *Wear* and *Tear*, because this title clearly and briefly points out my meaning. *Wear* is a natural and legitimate result of lawful use, and is what we all have to put up with as the result of years of activity of brain and body. *Tear* is another matter; it comes of hard or evil usage of body or engine, of putting things to wrong purposes, using a chisel for a screwdriver, a penknife for a gimlet. Long strain, or the sudden demand of strength from weakness, causes tear. Wear comes of use, tear of abuse. . . . Why is it that an excess of physical labor is better borne than a like excess of mental labor? The simple answer is, that mental overwork is harder, because, as a rule, it is closet, or counting-room, or, at least, indoor, work, — sedentary, in a word. The man who is intently using his brain is not collaterally employing any other organs, and the more intense his application the less locomotive does he become." — *Wear and Tear.* S. Weir Mitchell, M.D.

P. **254,** § **350** (*b.*). ***The Causes and Evils of Hysteria.*** — The term *Hysteria* is ordinarily applied by the laity to alternating conditions of the emotions, but by medical writers, refers to various phenomena of disturbed nervous force. It can simulate every known disease. The emotional variety, while it may be the result of incipient disease of the nervous system or some other part of the body, of overwork, or of worry, is too often due to the concentration of one's thoughts upon one's self, the desire for notoriety, etc. If hysteria is merely "a bad habit," it should be broken up, not only for the welfare of the individual afflicted, but because impressible friends may acquire similar habits, by imitation. The cure consists in a change of surroundings (of habitation, companions, etc.), and in hygienic measures. If the hysteria is the result of disease, it needs the best medical aid, for it is then a serious affection. Dr. S. Weir Mitchell, in speaking of the fact that men as well as women are liable to

hysteria, says: "I have many a time seen soldiers who had ridden boldly with Sheridan or fought gallantly with Grant, become, under the influence of painful nerve wounds, as irritable and hysterical as the veriest girl." In reference to the bad influences which hysterical persons exert, he writes truthfully: "A hysterical girl is, as Wendell Holmes has said in his decisive phrase, a vampire who sucks the blood of the healthy people about her, and I may add that pretty surely where there is one hysterical girl, there will be soon or late two sick women."

P. 255, § 351 (*a.*). ***The Time to be Devoted to Mental Labor.*** — In regard to the number of hours of mental labor per day each one should pursue, there has been and is a great diversity of opinions. Bulwer placed the number at three, while Sir Matthew Hale allotted six. It is said that on being asked how it was that he could do so much and such excellent intellectual work, giving only three hours a day to it, Bulwer replied: "Because I work three hours *every day*, never allowing myself to do more even when in the mood, and always filling the three hours even when I may be disinclined to work." It must be borne in mind that by the mental labor referred to above is meant *consecutive* and *earnest* intellectual effort, such as is adapted to one's ability, not the spasmodic or half-hearted work so often mistaken by novices for real work.

P. 265, § 367 (*a.*) ***What the Sense of Smell does for Us.*** — "Of all our senses, smell is the one that soonest gets out of practice, so much so that numbers of people really do not perceive disagreeable smells at all. If they always accustomed themselves to take notice, and to use their noses, they never would consent to live in the horrid air they do That is a grand use of the sense of smell. It tells a person who attends to it, that there is some bad or injurious thing mixing itself in the air. A sensible person then sets to work to get rid of that thing, whatever it may be, and to make his air clean again. A stupid person takes no notice, and then his nose gets used to the disagreeable smell, and leaves off perceiving it." — J. BERNERS. *Lessons on Health*

P. 283, § 384 (*a.*). ***The Importance of the Convergence of the Eyes in Vision.*** — "To direct both eyes to the same point requires a delicately balanced associated action of several muscles of each eye. In any part of the body, where a certain set of muscles are accustomed to act together in a given direction, this particular combination of movements becomes natural and easy, and any other comparatively difficult. This may be appreciated, for instance, by any one who has undertaken to drive a nail into the ceiling, and has experienced the fatigue of the muscles of the arm and neck and back that follows almost immediately. We are accustomed always, in converging the eyes towards any small object, at the same time to direct them downwards, as the object is usually held in the hand, or lies on

something before us, below the level of the eyes. This facility of turning both eyes inwards and downwards at the same time has not only been acquired by the individual, but has been inherited from his ancestors, and has become a part of his nature; so that the association of convergence with any other than a downward movement demands an extraordinary effort. This is a cause of fatigue in looking at pictures hung high in a gallery. Considerable interest has been excited recently by an affection noticed in miners, and called 'miner's nystagamus,' in which the external muscles of the eyeball seem to lose their balance, and the eyes continually oscillate. It is thought to result from the unnatural position of the eyes in working at the roof of the subterranean cavern in which these men pass their lives" — *Eyesight and How to Care for it.* American Health Primer

P. **284**, § **386** (*a*.). ***Test for Color-Blindness.*** — Of late, in certain countries, much attention has been drawn to the subject of color-blindness, and it has been suggested that other colors than red and green should be used for signals. In these countries, all railroad engineers, pilots, switchmen, etc., are tested as to color-blindness. Such examinations should be universal. In old people in whom the lens is liable to be yellowish, colors must be very bright before they can be readily distinguished From examinations made by Dr. Jeffries of Boston, he concludes that about one male in every twenty-five is color-blind, and that color-blindness is much less frequent among women. It can be easily tested in schools, etc. (where it is found to be quite common) by Holmgren's method. "It consists in providing a large pile of worsteds of different colors, and requiring the person examined to select the skeins which resemble the sample shown by the examiners. This method is simple, rapid, and scientific, and requires no naming of colors, which is a frequent source of fallacy and confusion. Even the normal-eyed are often at variance about color nomenclature. By this method a hundred persons may be accurately examined in an hour, and without error."

P **285**, § **387** (*a*.). ***The Disadvantages of Short Sight.*** — Short sight is said to be seldom found among farmers, seamen, and Indians, but is quite common in large cities, among students, engravers, artists, etc., especially if they work by a flickering light, or one that shines brightly from in front directly upon the work. From an examination of the eyes of pupils between six and twenty-one years of age, in various schools throughout the country, by Drs. E. G. Loring, R. H. Derby, A. R. Mathewson, and J. S. Prout, it has been ascertained that among the lower classes 3.5 per cent were near-sighted, and among the higher 26⅗ per cent. In Germany the percentages are said to be even greater; and it is rare to find army officers who do not wear spectacles. It may be that if as large a proportion of persons in this country with optical

defects should wear glasses as is the case in Germany, we would be considered as equally near-sighted. "A child may be thought a dullard, and to have no aptitude for observation or learning; he may be counted cold-hearted and unresponsive when his face does not light up at the smile of his mother or the caress of his sister; he may be esteemed sullen or stupid; he may be counted a bad playfellow; he may be thought eccentric or peculiar because he does not behave like other children. All this and more may be the character ascribed to him because his misfortune is to have bad sight. Beside this, it is a truth in mental philosophy that exactly such a character may be fastened upon him for life, because in his young days he was cut off from enjoyment of the visible world on terms of equality with his fellows Do we not know that dim-sighted persons are apt to be queer? If their deficiencies had been noted and corrected at an early stage of life, who can say how much more symmetrical would have been their adult character, and how much happiness society and the family might have enjoyed from them." — *Eye Troubles in General Practice.* PROF. H. D. NOYES of New York.

P. **284,** Note (*a*.). ***Dr. Snelling's Test Types.*** — In order that readers may ascertain whether they have normal vision, a (partial) list of Professor Snellin's test types is subjoined. The figures over the letters indicate the number of feet at which the letters should be distinctly legible.

1 ft. 8½ in.

OSLAGHOTEU

2 ft. 6 in.

ULHOEDTSFG

3 ft. 3½ in.

FOECHSUTDL

4 ft. 6 in.

ECLSTUFDOH

6 ft. 1⅓ in.

SLFDCEUHTO

7 ft.

DFSEOLUHCT

9 ft.

TCHDFSEULO

P. 287, § 391 (*a*.). ***Injurious Effects of Certain Occupations upon the Eyesight.*** — "The knowledge of the injurious effects of certain kinds of schooling upon vision is not a new acquisition; for Beer wrote more than sixty years ago, 'He who has taken the fruitless pains as often as I have, to try and impress upon parents and friends, in the most friendly manner and upon the most convincing grounds, the mischievous effect upon the eyes of growing children of the forcing-house system of the present day, will still be disheartened to find his well-intended counsel, based upon long experience, and often repeated, either entirely neglected, or listened to only by a few.' . . . Because people hold the imperfectly understood principle that children should be constantly occupied, there is at all hours of the day a master at hand. There is reading, writing, language-learning, drawing, arithmetic, embroidery, singing, piano and guitar-playing without end, until the persecuted victims are rendered pale, weak, and sickly, and to such an extent short-sighted or weak-sighted, that finally counsel must be obtained. . . . Of what avail is it to many charming girls, many estimable women, that as children they were regarded as prodigies, when the soundness of their eyes and the acuteness of their vision has been sacrificed." — *Eyesight, Good and Bad.* R. B. Carter, F.R.C.S.

P. 305, § 403 (*a*.). ***Sense Education.*** — Since writing what he has in connection with the development of the voice in those born deaf or with feeble minds, the writer has become acquainted with the excellent work accomplished by "sense education" in the Seguin Physiological School, New York. The following extract from a newspaper article, referring especially to the education of the voice in the feeble-minded at the above-named school, is so *apropos* that it is appended: "There is that most depressing sight, the mouth of the child of feeble mind and body. Open it stands, gaping wide, with its pendulous lower lip. The facial muscles are ignorant of their duty. It is not will-power alone which will ever bring those lips together. Still this can be and is corrected The child is taught to close it. Constantly the gentle teacher brings her finger to the child's lip, and an effort is made, after a while, by a self-sustained will, to close it. Sometimes a straw is held in the mouth to show the child how to grasp it with the lips. After a while, when his attention is occupied with something else, he forgets to close it. The act of having his mouth open is noticed, and he shuts it at a word of command. He may have been perfectly unable a few months ago to arrest a flow of saliva from his mouth; but now this secretion, which was over abundant, has ceased. He might have been once a saddening sight to see; but now much of that idiotic blankness has gone. But is it simply the child's appearance which has been improved? No. A thousand

things may arise from this simple mouth-instruction which are of advantage to the child in the sense of a brain-awakening. His speech has been thick and unintelligible. How could the poor lad pronounce a word properly, hampered as he was with rigid lips? Now he is taught to pronounce letters properly. Every sound of every letter may have to be taught him. The lips become pliant, vibrate at last, and from what was a dumb, inanimate, resoundless block, distinct musical words now are flowing. The visitor is deeply impressed with what he has witnessed. He has seen the effect of constant, assiduous, philosophical training. He looks at a series of portraits of the children, and marks how rapid have been the changes. It is this sense-education which has taken from these drear faces their animal look, and made them human once more. Dr. Seguin it is, who, though he be dead now, has given new life to many of God's creatures, and it is his wife who has carried out his work."

P. **315**, § **413** (*a.*). *Rules for the Care of the Voice.* — "No man who is conscious of the ability to speak effectively can undervalue the power of a pleasant voice; and no hearer of a melodious voice but will acknowledge its influence. We have, probably, all been charmed and our attention riveted by such a voice, even when the discourse was not above commonplace. The converse of this is, alas, more often met with. It is a fact that many of the greatest thinkers, scholars, and writers use in public speaking and reading, a heavy, low monotone, or they rasp the ear with a high and strident pitch. Their 'thoughts that breathe, and words that burn,' fall lifeless and cold, nay, even weary, and repel their listeners, who experience a sense of relief when the inharmonious voice ceases; the speaker also being thankful that his painful struggle to be heard is over. How much the influence of the unfortunate possessor of such a voice is nullified! If a statesman, how small must be his success in directing the fortunes of a nation! If a clergyman, painfully will he feel that his earnest endeavors avail him nothing. If a barrister, he sees judge and juryman sleeping, and to the detriment of his client he may lose his carefully prepared case. Yet, in almost every instance, a voice which has no inherent beauty may, by correct training, become attractive and pleasant, and obtain clearness, smoothness, and commanding resonance."

"*Rules.* 1. Never endeavor to produce a vocal tone without having plenty of breath, and that thoroughly under control. 2. Hold the breath when *in*spired, and commence to *ex*pire only on commencing to speak or sing, that is, at the moment it is required to set the ligaments in vibration. 3. Do not think that loudness is essential to force or beauty; shouting is always injurious. The telling quality of *laryngeal* tone depends solely on the amplitude of the vibrations, and this is controlled solely and entirely

by the *will*, which directs the due proportion of air to set the vocal ligaments into more or less full vibration. For all purposes of practice it is especially advisable for the pupil to sing *piano*, which term does not imply diminished vigor, but simply reduced amplitude of the vibrations. 4. Never use the voice when functional failure gives warning that the organ or the general health is disordered. 5. Do not attempt to use the voice in unfavorable circumstances, as in the open air, especially if the weather be cold or raw, nor in a room impregnated with tobacco smoke, foul air, or dust. Above all, do not use the voice, even for conversation, in trains or vehicles, or in any circumstances of noise which will require undue functional exertion. In this connection it will be important to keep quiet and avoid chattering and laughing between songs or the acts of a drama or opera. 6. Do not use the voice for too long a period at a time but always cease before fatigue is experienced. Especially avoid *encores* of songs, which have required much exertion, or production of a telling high note in the final *cadenza*. It is but rarely that a song is sung as well on a re-demand as at first. 7. After continued singing or speaking, be careful to prevent exposure of the throat, either externally or internally, to the impressions of cold air. The same remark applies as to the necessity of guarding against sudden changes from hot to cold air, even when the voice has not been used." — *Voice, Song, and Speech.* Browne.

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